Washington State Department of Transportation

Memorandum

Date: April 26, 2006

TO: Messay Shiferaw/Le Nguyen
Northwest Region, MS NB82-60

FROM: Tony Allen/Todd Mooney
E&EP Geotechnical Branch, MS 47365

SUBJECT: SR-99, MP 12.15 to12.92, XL-1266
S. 284th to S. 272nd - HOV
Geotechnical Report

Attached with this memorandum is the Geotechnical Report for the subject project. The report addresses the following:

- Field investigation and testing
- Subsurface conditions and site seismicity
- Recommendations for design of soldier pile walls
- Recommendations for soil nail walls
- Recommendations for design of various preapproved proprietary retaining wall systems
- Recommendations for cut slopes
- Construction considerations

The geotechnical report should be made available at the project engineer's office for review by prospective bidders. Logs of all the borings in the referenced *Geotechnical Report* should be included in the *Contract*.

If you have questions or require further information, please contact Tony Allen at (360) 709-5450 or Todd Mooney at (360) 709-5463.

TMA:dtm

Enclosure

cc: Mark Gaines, Bridge Construction Engineer, MS 47354
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GEOTECHNICAL REPORT

SR-99 MP12.15 TO 12.92

South 284th to South 272nd - HOV

XL-1266

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EXPIRES 09-23-06

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EXPIRES 03-13-08

April 20, 2006

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1. INTRODUCTION

1.1. GENERAL

This report presents geotechnical recommendations for the South 284th St. to South 272nd St. Higher Occupancy Vehicle (HOV) project. Geotechnical recommendations are given in this report for design of the cantilever soldier pile walls, soil nail walls, cut slopes and structural earth (SE) walls. Widening of SR-99 will occur on the west and east sides of the existing roadway. The cut walls are required on the east side and the fill walls on the west side. A vicinity map of the project location is presented in Figure 1.

The analyses, conclusions, and recommendations in this report are based upon 15 borings completed specifically for the project, published geologic information for the site and vicinity and our experience with similar geologic materials. The exploratory borings are assumed to be representative of the subsurface conditions throughout the project area. During construction, if subsurface conditions differ from those described in the explorations, we should be advised immediately so that we may reevaluate our recommendations and provide assistance.

1.2. PROJECT DESCRIPTION

The project will add a HOV lane in each direction of existing SR-99 between South 284th St. and South 272nd Street. Other improvements include bus zone upgrades, Americans with Disabilities Act access, pedestrian safety and a signal priority system for buses. This project is part of a larger plan to add HOV lanes to SR-99 between SR-516 and South 320th Street. However, the section between S. 284th St. and S. 272nd St. is the only portion that WSDOT will design and construct.

As stated above, fill walls are required on the west side of SR-99 and cut walls on the west side. The cut walls will range up to about 12 ft in height. Fill walls will be up to about 16 ft in height.

2. FIELD INVESTIGATION AND LABORATORY TESTING

2.1. SUBSURFACE EXPLORATION AND LABORATORY TESTING

The initial subsurface investigation for this project was done by Civil-Tech Corporation (Bellevue, WA). The results of Civil-Tech's investigation and analyses were summarized in their report titled *SR99 HOV Lanes Project, Federal Way Washington*, and dated January 23, 2002. Their report should be referenced for full details of the subsurface investigation and laboratory testing. The Civil-Tech borings are designated as B-XX-01, and their locations are shown in Figures 2 to 4.

Logs for the borings done by Civil-Tech, revised to the format used by WSDOT, are included in Appendix A. The elevations on the original boring logs were 73 ft higher than the current project vertical datum, as reported by the Region. In addition, the stationing used for the original borings was different than the current project stationing. The logs in Appendix A reflect the project's current vertical datum and stationing. Other than changes to the stationing and elevations, the descriptions on the logs are the same as those in their original report.

Copies of the grain size distributions for various samples have been included in Appendix B. In addition to complete grain size distributions 200 washes were completed by Civil-Tech for 21 samples. Results of the 200 washes are noted on the logs in the Civil-Tech report. The percent fines and percent gravel have been included on the various soil profiles and cross-sections contained within this report.

In addition to the borings done by Civil-Tech, WSDOT drilled 7 borings that included piezometers. The WSDOT borings are designated as P-XX-05, and their locations are shown in Figures 2 to 4. These boring were done primarily to assess ground water conditions at the locations of proposed storm water detention tanks. No laboratory testing was done on samples recovered from these borings. Recorded ground water levels are shown on the individual logs.

3. GEOLOGIC SETTING

3.1. REGIONAL GEOLOGY

The project site is located in the central portion of the Puget Lowland physiographic province of Washington State. The Puget Lowland is a north-south trending depression bounded on the east and west by the Cascade Mountain Range and Olympic Mountains, respectively.

The topography and geology of the Puget Lowland are a result of several cycles of regional glaciation during the Pleistocene Epoch. The last glacial advance and retreat known as the Vashon Stade of the Fraser Glaciation ended approximately 10,000 to 13,000 years ago. At the height of the glacial advance, the Vashon ice, termed the Puget Lobe, is believed to have filled the lowland to a thickness of up to 5600 ft in the deepest part of the trough.

Topography of the lowland is characterized by generally north-south trending ridges and valleys that are the result of glacial scouring. These ridges and valleys have been modified by post glacial erosion and deposition. Elevations in the lowland range from below sea level to as much as 1000 feet. The deepest valleys are glacially sculpted troughs extending 160 to 300 ft below sea level and are inundated by marine waters of the Puget Sound.

3.2. SITE GEOLOGY

The following discussion of the general site geology is based on the geologic map of the Poverty Bay 7.5′ Quadrangle (Waldron, Booth and Troost, 2004). No bedrock is exposed at the site. Waldron, et al. (2004) report that within the Poverty Bay Quadrangle, bedrock, which consists of Tertiary age volcanic and sedimentary rocks, is at least 1300 ft below the surface. Surface deposits consist of glacially derived materials, as discussed below.

Mapped surface units at the site were deposited during the Vashon stade of the Fraser glaciation and consist of materials with widely varying textures resulting from the rapidly changing depositional environments that occurred during the Vashon stade. Surface units mapped at the site include Vashon till, recessional outwash and pre-Olympia age glacial deposits. The till unit consists of subrounded to well rounded clasts in a matrix that is usually silty sand or sandy silt. There are lenses of sand, gravel and silt. Larger clasts are usually cobble size or less. Boulders larger than 3 ft in diameter are reported to be uncommon.

The recessional outwash is described as containing poorly graded sand and gravel and some silty sand and silt. The pre-Olympia age glacial deposits are described as containing silt, sand and gravel. The pre-Olympia age unit underlies all of the Vashon aged deposits.

Existing SR-99, within the project limits, lies entirely within the mapped till unit. The pre-Olympia age deposits occur on the south western edge of the project. The recessional outwash deposits are mapped as occurring on the west side of the project, in the vicinity of the 16th Ave. S. intersection.

3.3. SITE SEISMICITY

The tectonic structure and stresses in Western Washington are mostly associated with the subduction of the Juan de Fuca Plate under the North American Plate. Under the framework of the subduction zone, the region can be divided into three tectonic provinces: (1) the Juan de Fuca Plate, (2) the continental forearc on the western edge of the North American Plate, and (3) the landward continental volcanic arc. Regional faulting and structural trends, especially in the Puget Lowland, are greatly complicated by the glacial and non-glacial soil deposits masking the bedrock.

Within this tectonic environment four potential seismic sources can be identified. Interplate and intraplate seismic activity associated directly with the subduction of the Juan de Fuca under the North American Plate, seismic activity associated with the volcanic arc and shallow crustal earthquakes.

Interface, or subduction zone, earthquakes take place at the boundary of the Juan de Fuca and the North American Plates. Although a subduction zone earthquake has not been recorded off the coast of Washington or Oregon during historic time, geologic evidence suggests that they may occur. The last great earthquake to occur on the interface zone appears to have occurred around 1700. Studies of recurrence suggest that the average recurrence interval is about 450 years with a 90 percent confidence interval of about 200 years. A magnitude M8 to M9 earthquake is believed possible along the subduction zone, however, the best estimate is M8.3 (USCOE, 1994 and Geomatrix, 1995).

Intraslab earthquakes take place within the subducting Juan de Fuca Plate at depths between 25 to 40 miles. These earthquakes occur inland from the interface earthquakes. Intraslab earthquakes have occurred in the Puget Sound region, with five historical earthquakes having magnitudes greater than 6. The largest earthquakes include the 1949 magnitude 7.1 Olympia Earthquake, the 1965 magnitude 6.5 Seattle-Tacoma Earthquake and the 2001 magnitude 6.8 Nisqually Earthquake. The recurrence interval for intraslab earthquakes is highly uncertain, however, Geomatrix (1995) suggests a 1,000-year and 5,000-year recurrences for M7 and M7.5, respectively.

The third major type of earthquake is the crustal earthquake, which occurs in the North American Plate, typically at depths between 6 and 12 miles. Several earthquakes, between M4.0 and M5+, have occurred in the Cascade Range over the past 150 years. The maximum expected magnitudes for crustal earthquakes varies throughout the state and depends on the thickness of the crust and the length and rate at which seismic strain accumulates on faults.

4. SUBSURFACE CONDITIONS

4.1. SITE SOIL CONDITIONS

For this report, the soil deposits described in the Civil-Tech report have been grouped into two soil units for geotechnical distinction. The soil units are grouped primarily on the basis of engineering properties and classification and, in general, reflect depositional environments as well. The differentiation between the units was determined primarily upon the fines content (percent less than 0.075 mm) and the percent gravel (percent greater than 4.75 mm). As mentioned above, the fines content and percent gravel are shown on the various soil profiles. The units are individually described below, and abbreviated descriptions are included on the soil profiles.

Unit 1 – Silty Sand with Gravel: Unit 1 is interpreted as glacial till and advance outwash. The fines content of Unit 1 ranges from about 8 to 48% with most values being between 15 and 35 %; the average fines content is 26 percent. There were only 7 determinations made of the percent gravel of this unit. The percent gravel ranges from about 8 to 47% and averages about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01 at El. 240 ft, B-5-01 at El. 287 ft and B-8-01 at El. 303 feet. Cobble rich layers were noted in borings B-2-01 between El. 300 and 310 ft, B-3-01 at El. 310, B-4-01 at El. 275 ft and B-7-01 at El. 296 feet.

Unit 2 – Sand and Gravel with Cobbles: Unit 2 is distinguished from Unit 1 primarily by its higher gravel content, lower fines content and the occurrence of cobbles and boulders. Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. Unit 2 appears to dip to the north, occurring at an elevation ranging from 296 ft in B-8-01 to 265 ft in B-4-01. In B-4-01, Unit 2 occurs within Unit 1. The fines content of Unit 2 ranges from about 9 to 40% with most values being between 9 and 15 percent. Omitting the highest fines content, the average fines content is 13 percent. There were only 3 determinations made of the percent gravel of this unit. The percent gravel ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 near El. 297 ft, and cobbles occurred throughout the soil mass below about elevation 278 feet. In B-8-01, a 4 ft thick zone of boulders was reported beginning near elevation 284 feet.

4.2. GROUND AND SURFACE WATER

Ground water levels recorded in the seven piezometers varied between elevation 225 ft (P-4-05) and 286 ft (P-1-05). As noted above, individual piezometer readings are recorded on the boring logs. All of the soil nail and soldier pile walls are located above the ground water elevations recorded in the piezometers, however, there may be perched water, as discussed below.

At the time of drilling, perched ground water was noted in borings B-4-01 (El. 237 ft), B-5-01 (El. 262 ft), B-6-01 (El. 310 ft) and B-8-01 (El. 297 ft). In B-4-01 the perched water was noted within a silt layer and in B-8-01 the perched water was recorded just above a layer with a fines content of 40 percent. In B-5-01 and B-6-01, the confining layer was not well defined.

Glacially deposited soils often have relatively impermeable layers over which water may become perched, and these layers could be missed during the subsurface exploration. Therefore, there may be areas within the wall construction zones that have perched water that were not identified in the subsurface exploration.

5. GEOTECHNICAL RECOMMENDATIONS

5.1. DESIGN EARTHQUAKE PARAMETERS

For seismic design of the walls, a peak ground acceleration of 0.33g is recommended in accordance with the WSDOT *Bridge Design Manual*. This peak ground acceleration is consistent with the 2002 USGS National Seismic Hazards Mapping Project of peak bedrock acceleration with 10% probability of exceedance in 50 Years.

5.2. LIQUEFACTION POTENTIAL

Liquefaction of saturated sands occurs when the sands are subject to cyclic loading. The cyclic loading causes the water pressure to increase in the sand, thus reducing the intergranular stresses. As the intergranular stresses are reduced, the shearing resistance of the sand decreases. If pore pressures develop to the point where the effective stresses acting between the grains become zero, the soil will behave like a viscous fluid. Under this condition a soil layer loses part of its shear strength, and the result is usually rapid settlement. For deep foundations, downdrag forces will be generated as a result of settlements within and above the liquefied layer. Side capacity will also be lost in units over the liquefiable layer. Within the liquefied layer, there will be a loss of lateral support and of side resistance.

The liquefaction potential of saturated soils is evaluated mainly on soil gradation, relative density and the depth of the deposit, i.e., the vertical effective overburden stress. The potential for liquefaction is highest for loose, fine to medium grained, sandy and silty soils. Increasing fines content, i.e., silt and clay, decreases the potential for liquefaction. If a deposit has greater than 35% fines it is usually considered to be non-liquefiable. Due to their high hydraulic conductivity, gravel soils are less susceptible to liquefaction, however, they can liquefy depending on their fines content, thickness, areal extent and/or the drainage conditions at their boundaries. The potential for liquefaction of all cohesionless, granular soils decreases with increasing depth and relative density.

At the project site, the subsurface investigation and laboratory testing has not indicated the presence of any liquefiable soils.

5.3. LIQUEFACTION INDUCED LATERAL SPREADING AND STRAIN

Due to the absence of liquefiable soils at the site, there will be no liquefaction induced lateral spreading during an earthquake event.

5.4. RETAINING WALLS

5.4.1. WALL 4 AND WALL 5A (SOLDIER PILE WALLS)

We are recommending cantilever soldier pile walls for these wall locations (Fig. 2 and 5). This type of wall will be advantageous at these locations because there is only about 5 ft between

the proposed wall alignments and right-of-way (ROW), and use of the cantilevered soldier pile walls will essentially eliminate the need for excavation behind the wall face.

A complicating factor for each of these walls is the presence of detention tanks near the proposed wall faces. The tanks have been designated tank #1, at Wall 4, and tank #2, at Wall 5A. The existing detention tank locations, as provided by the Region, are summarized in Table 1 below and shown in plan view in Figure 5; these locations should be clearly noted in the contract wall plans.

In the case of detention tank #1, at Wall 4, it is only the west end of the tank that affects the wall. The Region has secured an agreement with the owner to remove approximately 12 ft of the tank behind the wall face. We understand that the removal is to take place prior to beginning wall construction. In order to facilitate construction of Wall 4, the excavation for the tank removal should be backfilled with select or common borrow. This would likely avoid the need for temporary casing for the installation of soldier piles along this portion of Wall 4. The backfill material should be compacted using method B, as outlined in the *Standard Specifications*, or alternately, controlled density fill could be used.

At Wall 5A the tank is essentially parallel to the wall face, and it is our understanding that the tank will remain. To accommodate the tank, the wall was moved approximately 8 ft west. However the nature, extent and condition of the backfill for this tank are unknown. This creates the potential for complications during wall construction; these are discussed under *Construction Considerations*.

At the tank sites, the retained soil will not be native, undisturbed material. Therefore, the earth pressure diagrams are affected. In the case of Wall 4, where only a relatively short portion of the wall will be affected by the removal of the 12 ft portion of tank #1, the earth pressure diagram assuming the presence of native material should be acceptable for design. However, at Wall 5A where the entire length of the tank is parallel to the wall face and the condition of the backfill is unknown, as stated above, a different earth pressure diagram should be used. These are discussed below.

Table 1: Detention Tank Locations and Dimensions

Tank #	Affected Wall	Tank Properties			Approximate Station Limits	Comments
		Length[1] (ft)	Diameter (ft)	Material		
1	4	110	7	Concrete	40+91.6 (54.02 RT) to 41+23.95 (158.82 RT)	• 12 ft of the tank behind wall to be removed *prior* to wall construction
2	5A	95	5	CMP	43+13.39 (62.08 RT) to 44+00.35 (62.7 RT)	• Offset is distance to centerline of tank • Tank is about 8ft from back of wall • Tank is to be remain

Notes: 1. Includes the catch basins at the ends of tank

The generalized soil profile for Walls 4 and 5A is shown in Figure 6. The soil profile for the walls was assessed from borings B-6-01, B-7-01 and B-8-01. The design soil parameters for the walls and the applicable station limits are summarized in Table 2. The wall section at station 40+50, shown in Figure 7, was used for the design of Walls 4 and 5A. Although there is no

boring within the station limits of Wall 4, the geology at the site is relatively homogeneous with regard to the presence of dense glacially deposited materials. However, the composition of the materials may very considerably, e.g., silty sand to relatively clean gravel. Therefore, it is our opinion that the risk of subsurface conditions at Wall 4 that are significantly different from those indicated by the referenced borings is sufficiently small to warrant the omission of a boring or test pit along this wall.

The earth pressure diagram in Figure 8 should be used for design of Wall 4 and those portions of Wall 5A outside the detention tank limits. For the design of Wall 5A, to adequately account for the difference in the earth pressure due to the backfill of tank #2, the limits of the tank are assumed to extend from 43+08, i.e., about 5 ft down station of the tank, to the end of Wall 5A. The earth pressure diagram in Figure 9 should be used to design Wall 5A up station of 43+08.

The earth pressure diagrams in Figures 8 and 9 were provided to the Bridge and Structures Office for completion of the structural portions of the wall, i.e., the pile sections and the required pile embedment depths. The diagrams assume that the final grade at the toe of the walls will be essentially horizontal.

In addition to development of the earth pressure diagrams, our analysis for Walls 4 and 5A consisted of a check of global stability and an assessment of vertical and horizontal wall deflections. For Walls 4 and 5A a minimum embedment depth of 8 ft for the soldier piles should be sufficient to provide for a factor of safety against global failure that exceeds 1.5 (calculated factors of safety exceed 2). A traffic surcharge of 250 psf was included in the analysis due to the presence of parking lots above the wall.

Table 2: Soil Parameters for Design of Soldier Pile Walls 4 and 5A

Parameter	Applicable Values	
	All of Wall 4 Wall 5A Sta. 41+89.3 to 43+08	Wall 5A Sta. 43+08 to 44+15.64 (End of Wall)
Unit Weight (γ)	130 pcf	130 pcf
Soil Friction (ϕ_f)	40°	38°
Active Earth Pressure (K_{a1})	0.22	0.27
Active Earth Pressure (K_{a2})	0.22	0.2
Passive Earth Pressure (K_{p2})	12	12
Seismic Active Earth Pressure (K_{ae})	0.35	0.45
$\Delta K_{ae} = K_{ae} - K_{a1}$	0.13	0.18

To ensure drainage for the walls, geocomposite drainage mats should be installed between the lagging and the permanent fascia of the wall. The drainage mats should tie into an underdrain at the toe of the wall. The underdrain should remove drainage from the wall area. Additionally, we recommend the construction of a gutter at the top of the wall to direct surface runoff from behind the wall.

Known underground utility conflicts associated with Walls 4 and 5A consist primarily of detention tanks #1 and #2, which have been discussed above. The existing underground utilities,

according to the site plan in Figure 2, are outside the construction zones for Walls 4 and 5A. Any utilities that are either to remain or be removed during construction should be clearly shown on the wall plans so that prospective bidders can properly include the associated costs in their estimates.

5.4.2. WALL 5B, WALL 6 AND WALL 7 (SOIL NAIL WALLS)

Soil nail walls are feasible for Walls 5B, 6 and 7. We understand that enough subterranean easement is available to accommodate nail lengths of up to 14 feet. Rock walls were also considered for these walls. However, it was determined that the excavations behind rock walls would be too large, especially on Wall 7. On June 13, 2005 the Region requested that soil nail walls be designed for Walls 5B, 6 and 7.

A 210 ft long detention tank had been proposed for installation immediately in front of Wall 7, at a depth of about 16 ft below final grade. The beginning of the tank was to be at about station 49+50. Situating the tank in this location would have required shoring an excavation of up to 28 ft deep. Although the soil is such that shoring or sloping could have been accomplished fairly readily, right-of-way restrictions would have prevented the construction of conventional shoring systems, e.g., tied back soldier pile wall or soil nail walls, and would not allow room for temporary slopes. The excavation height would have required that soil nails or permanent ground anchors extend beyond available subterranean easement. Alternatives for the detention tank's location were discussed in a meeting at the Region office on July 25, 2005.

It was decided to locate the tank in the median of SR-99. At this location, the tank will have no affect on the design of Wall 7. Partially in response to the relocation of this tank, additional borings that included piezometers were installed by the NW Region. As mentioned above, the logs for these borings are included in Appendix A.

Soil conditions for Walls 5B and 6 have been developed from boring B-5-01, which is within the station limits of the walls but offset about 111 ft west of the wall, and borings B-3-01 and B-6-01, which are located within the same slope but approximately 280 ft ahead and 145 back, respectively, of the wall limits, see the boring plan in Figure 2. The generalized soil profile is shown in Figure 10. The wall section at station 47+80, shown in Figure 11, was used for the design of Walls 5B and 6. This station is within Wall 6.

Subsurface conditions for Wall 7 were developed from borings B-2-01, B-3-01, B-4-01, P-1-05 and P-7-05, see Figure 2 and 3. The generalized subsurface profile is contained in Figures 12 and 13. The wall section at station 51+80, shown in Figure 14, was used for the design of Wall 7.

The subsurface conditions at all three walls were assumed to consist of Unit 1 soils within the wall profile and for a significant depth below the finished grade. As discussed above, Unit 1 consists primarily of silty sand with gravel. However, layers of cobbles were encountered at elevations that are either within the wall profiles or very near to them. For example, cobbles were noted in borings B-2-01 and B-3-01 at elevations that lie within Walls 5B, 6 or 7. Because the site appears to have till and outwash interfingered with one another, the cobbles may represent outwash deposits and could therefore, be relatively clean and hence susceptible to caving.

The section used for design of Walls 5B and 6 was at station 47+80 (Fig. 11), which is along Wall 6. The design wall height was 11 ft, and the backslope was 8°. The height of wall used in design assumes 2 ft of embedment below finished grade. Verification checks were made at Sta. 48+20, on Wall 6, which has a steeper backslope (15° vs. 8°) and only 2 rows of nails, and at station 47+01, which is the critical section for Wall 5B, where H = 10 ft and $\beta = 10°$.

At the design station for Wall 7 (Fig. 14), the wall height is 12 ft and the existing, and final, backslope is 1:1. The steep backslope required longer soil nails and shorter horizontal soil nail spacing than either Wall 5B or 6.

The backslope on Wall 7 was modeled as a surcharge of height 6 ft, as determined from the geometry at Sta. 51+80 (Fig. 14). The surcharge height was determined as the height to the first break in the slope above the top of the proposed wall. A unit weight of 130 pcf was assumed for the retained soil, therefore the surcharge is: 6 ft (130 pcf) = 780 psf.

The soil nail layouts and schedules are presented in Figure 15 for Wall 5B, Figure 16 for Wall 6 and Figure 17 for Wall 7. The design parameters and analyses for the soil nail walls have been predicated on the following assumptions:

1. Grade 60 bars (minimum) will be used as the soil nails.
2. A minimum ultimate nail head strength of 30 kips and an allowable nail head strength of 20 kips is used.
3. A 6 inch diameter borehole is assumed.
4. Wall backslope is not steeper than 3H:1V at Walls 5B and 6 and not steeper than 1:1 at Wall 7
5. Minimum factor of safety for completed walls = 1.35.
6. Minimum factor of safety during construction = 1.2.
7. Minimum factor of safety for seismic loading = 1.1.
8. Verification testing will be performed as summarized below.

Existing rock walls extend perpendicular to the end of Wall 5B and the beginning of Walls 6 and 7. A plan view of the affected portions of the walls is shown in Figure 18. In order to ensure that there is adequate cover on the soil nails, the soil nails at these locations must be splayed about 10° to the wall face, as shown in Figure 18. The affected nails are also noted on the respective soil nail layouts (Figs. 15 to 17).

We recommend that a prefabricated drainage composite be placed vertically between the nails. The drainage composite should be placed between the shotcrete and the excavated face then connected to an underdrain below the finished grade. The finished grade in front of the wall should direct the water away from the wall face. A gutter should be constructed at the top of the wall to collect surface water and direct it away from the wall face.

Verification testing of the nail installation procedure and design assumptions will be required. These tests will be conducted prior to beginning any excavation for the construction of the walls. The nails used will be considered sacrificial. The test nails should be located within the nail pattern. Bare bars may be used for sacrificial verification test nails. The purposes of the

verification tests are to confirm the design load transfer (DLT) values that have been assumed in the design and to verify that the proposed construction techniques are appropriate for the existing ground conditions.

Verification test nail locations are summarized in Table 3 for Walls 5B and 6 and in Table 4 for Wall 7. Exact verification test locations shall be specified in the field. The assumed values of design load transfer are included in the nail schedules and should also be included in the contract documents. The design load transfer was computed by dividing the ultimate pullout resistance by a factor of safety of two (2).

Table 3: Soil Nail Verification Test Locations for Walls 5B and 6

Wall	Soil Type	Location (STA to STA)	Elevation (ft)	Design Load Transfer (lb/ft)	Number of Successful Tests
5B	Unit 1[1]	46+60 to 46+80	313 ± 1	1500	1
6	Unit 1[1]	47+70 to 47+90	309 ± 1	1500	1

Notes: 1. Unit 1 is dense, silty sand with gravel, see report text and boring logs for additional details.

Table 4: Soil Nail Verification Test Locations for Wall 7

Soil Type	Location (STA to STA)	Elevation (ft)	Design Load Transfer (lb/ft)	Number of Successful Tests
Unit 1[1]	49+80 to 50+25	302 ± 1	1500	1
Unit 1[1]	51+50 to 52+00	296 ± 1	1500	1
Unit 1[1]	54+50 to 55+00	287 ± 1	1500	1

Notes: 1. Unit 1 is dense, silty sand with gravel, see above text and boring log for additional details.

In addition to the preproduction verification tests, proof tests must be performed on production nails. Test procedures, frequency and acceptance criteria are outlined in the *Standard Specifications* [6-15.3(8)].

There are existing overhead power lines along Walls 5B, 6 and 7 that may interfere with wall construction if not relocated or removed prior to beginning work. There are no known underground utility conflicts associated with Walls 5B and 6. Known underground utilities are shown in Figure 2. If any utilities located within the wall construction zone (including the nail zone) are to either remain or be removed during construction, they must be clearly shown in the contract documents so that prospective bidders can properly include the associated costs in their estimates.

At Wall 7 there are no known, existing underground utility conflicts. Known underground utilities are shown in Figures 2 and 3. However, there may be some conflicts with a Puget Sound Energy (PSE) power pole that is to be installed at Sta. 52+35, 72 ft (RT), prior to beginning work on Wall 7. Implications to the design of Wall 7 as well the effects of the power pole on construction are discussed below.

5.5. POWER POLE AND LUMINAIRE PLACEMENTS

Cut Walls (Walls 4, 5A, 5B, 6 and 7)

Plan locations for luminaire and power poles are shown in Figures 2 to 4. Power poles located near Walls 4 and 5A are shown on the wall and soil profiles in Figure 6. Power pole locations near the alignments of the soil nail walls (Walls 5B, 6 and 7) are shown on the respective soil nail layouts in Figures 15 to 17. For the solider pile walls (4 and 5A) luminaries will be mounted on the wall, as will the luminaires located along Wall 7. The Bridge and Structures Office is designing the permanent wall fascia of these walls to accommodate the luminaires.

For power pole placements outside the wall limits but very near the ends of the walls, the Bridge and Structures Office has suggested extending the permanent fascia of the wall to the pole. This would retain the soil between the end of the wall and the power pole.

Only the power pole at Sta. 52+35 actually occurs within the limits of a wall (Wall 7). This pole is to be installed by PSE prior to beginning wall construction. Based on discussions with PSE, the pole will extend 71 ft above existing grade. It will consist of a pole embedded 28 ft into a 3.5 ft diameter (0.5 inch thick) steel casing that is to be embedded 33 ft below existing grade. The annulus between the pole and casing will be filled with granular material. Currently, the proposed offset of 72 ft (RT) for the power pole places it about 8 ft behind the wall face and therefore within the soil nail zone.

The power pole at Sta. 52+35 has both design and constructability issues for Wall 7. Since the power pole will be located only about 8 ft behind the wall face it will transmit lateral load to the wall face. Also, as stated above, the pole will be within the nail zone. The nail layout has been adjusted to accommodate the power pole (Figs. 17).

The following loads at the ground surface were provided by PSE for the power pole: shear = 3.5 kips, moment=185 kip-ft and vertical = 1.9 kips – not including selfweight. We understand that these loads represent the combined wind and line tension loads. Using these loads, the distribution of soil/pole reaction with depth was determined using SIL-Shaft. Input parameters used in the analysis are summarized in Appendix C. The resultant load was determined as the area of the soil/pole reaction distribution. The resultant load was then transmitted to the wall face over an area determined by projecting lines at 2V:1H from the edges of the power pole. Distributing the loads over this projected wall area, lateral pressures of about 180 psf were estimated for the upper 5 ft of the wall and 90 psf for the remainder of the wall. Four additional nails were added near the power pole to accommodate the resultant loads from these pressures.

Fill Walls (1A, 1B, 2A, 2C, 2D, 3A, 3B and 8)

Currently, all of the fill walls on this project are proposed as pre-approved, proprietary structural earth (SE) walls. Power poles or luminaires that are to be located within the reinforcing zone of these walls must be clearly shown on wall plans provided to the manufacturer for the internal wall design. This will enable them to account for the reduced reinforcing area that will occur at the power pole or luminaire locations. Some of the shorter walls will likely be constructed without reinforcing.

5.6. SE WALLS (1A, 1B, 2A, 2C, 2D, 3A, 3B AND 8)

Recommendations for mechanically stabilize earth (MSE) walls were provided in the Civil-Tech report. That report contained recommended design bearing capacity parameters. These have been supplied to the design office for inclusion in the *Special Provisions*. Settlement and global stability were not specifically addressed in the Civil-Tech report. With the exception of Walls 1A and 1B the SE walls on the project have exposed heights of 5 ft or less. Consequently, we have examined external stability, with regard to settlement and global stability only for Walls 1A and 1B.

The generalized soil profile for Walls 1A and 1B are shown in Figures 19-21 and 23, respectively. The soil profile was characterized by borings B-2-01, B-3-01, B-4-01, B-5-01, B-6-01, B-8-01, P-1-05 and P-7-05. Soils within the wall elevations generally appear to be loose to medium dense unit 1 materials. Specifically, borings B-4-01, B-5-01, B-7-01, B-8-01 and P-7-05 all indicate loose to medium dense silty sand, sandy silt and sand occurring within the wall elevation. However, the foundation materials for the walls appear to be the dense to very dense unit 1 soils.

Based on our analyses, we expect settlements of both walls to be 1 inch or less and post-construction settlements to be negligible. Portions of the walls have toe slopes between 1.5H and 2H:1V an embedment depth of at least 2 ft, with a 4 ft horizontal bench at the toe of the wall will be required to obtain the recommended bearing capacities and provide for overall global stability.

5.7. CUT SLOPE (STA. 44+15 TO 46+25)

It is our understanding the owner of the parcel between walls 5A and 5B (Sta. 44+15 to 46+25) requested a 2H:1V slope instead of a retaining wall. By inspection, 2H:1V slopes should be stable in the dense glacially deposited soils that are expected within the slope.

6. CONSTRUCTION CONSIDERATIONS

6.1. SOLDIER PILE WALLS

Installation of the soldier piles will require excavation through dense to very dense material. This material should be encountered within 5 ft of the surface at Walls 4 and 5A, except at the locations of the detention tanks, which are discussed below.

Due the presence of cobbles and the potential for the occurrence of boulders (since the native soils are of glacial origin) the contractor should have tools on-site for the removal of obstructions. The highest elevation recorded for perched water was 317 ft in B-6-01. Near the

end of Wall 5A the bottom of the wall is near elevation 317 feet. Therefore, some perched water should be expected during installation of the soldier pile shafts for Walls 4 and 5A. We expect the quantities of inflow to be limited and expect that neither temporary casing nor slurry will be required for installing the soldier piles in the native material. Based on the recorded ground water elevations, ground water should not be a major problem during face excavation of the soldier pile walls.

At Wall 4 the detention tank will be replaced prior to construction. Therefore, if cohesionless backfill is used, soldier pile installation at this location may require temporary casing to support the backfill material. The nature of the backfill for the tank at Wall 5 is not known. Depending on the exact nature of the backfills and the level of compactive effort used during placement, there may be potential face stability problems when excavating for Walls 4 and 5A in the vicinities of the tanks. Most likely, these problems would be manifested as sloughing between the soldier piles. Otherwise, we are not anticipating that temporary casing will be necessary for installation of the soldier piles on Wall 4 or 5A.

6.2. Soil Nail Walls

Due to the potential for the occurrence of cohesionless soils in the vicinity of the wall face, there is a risk that portions of the wall face will slough during wall construction. The contractor will need to be prepared to take measures to prevent this sloughing. Furthermore, prior to beginning any excavation for the wall, surface water must be controlled from entering the face area. This is to prevent the weakening and attendant sloughing and/or erosion of soil near the face of the excavation. Other than creating instability at the face of the excavation, water can also inhibit the bonding of the shotcrete to the excavated wall face.

We also anticipate that during drilling for the soil nails, zones of cohesionless soils will be encountered, and therefore caving conditions may be encountered during nail installation. Additionally, several borings (B-2-01, B-3-01, B-4-01 and B-7-01) indicated the presence of cobbles. Therefore, in addition to potential caving, difficult drilling conditions should be anticipated by the contractor. The contractor should be prepared take measures to prevent caving of the wall face (see discussion below) and/or of the borehole during soil nail installation. Casing can be used to maintain an open borehole.

In areas where it is difficult to maintain the excavated face, several steps can be taken to enhance its stability. For instance, a stabilizing berm can be used during nail installation. Slot cutting can be used, i.e., opening the excavation just wide enough to install the nail. Finally, coating the open face with shotcrete, then installing the nail through the shotcrete, could be used to enhance face stability during nail installation.

The control of water is also of paramount importance in maintaining a stable face during excavation. Surface water should be directed away from the face of the wall, as discussed above. We expect that any ground water encountered will be perched and of limited volume. However, the contractor should be equipped to provide means of draining ground water from localized areas. Horizontal drains are one method of removing ground water from behind the excavation face. Construction in dry months is recommended.

The power pole at Sta. 52+35, which was discussed above, may create some conflicts with the soil nails. As stated above, the soil nail layout has been adjusted to accommodate the power

pole, based on its proposed location. If the pole is located other than where it was proposed, there are likely to be conflicts between it and the soil nails. Adjustments to soil nail locations of up to 25% of the nail spacing are permitted in the field. If larger adjustments are necessary, the Headquaters Construction Office and the Geotechnical Division should be notified.

6.3. SE WALLS

Cuts necessary for Wall 1A will extend below the recorded elevation of the perched ground water in boring B-6-01 (Sta. 44+80). Therefore, water may be encountered during construction of Wall 1A in this vicinity.

Near Sta. 64+40, the bottom elevation of Wall 2D will be only 1 to 2 ft above the highest recorded ground water elevation (247 ft) in P-3-05. Near the end of Wall 8 its bottom elevation will be near or at the highest recorded ground water elevation (260 ft) in P-2-05. The other MSE walls on the west side of the alignment are situated above the recorded ground water levels.

Temporary slopes or shoring will be required to support existing lanes of SR-99 during construction of the MSE walls on the west side of the project.

Walls 1A and 1B are being built on existing slopes. There may be limited access and work space available on the downslope sides of these walls.

6.4. CUT SLOPE

At the cut slope between Walls 5A and 5B (44+15 and 46+25), overhead power lines occur within the construction zone for the cut slope sections. Relocation or resetting of the utility poles will be required. We recommend that power lines be relocated outside of the cut slope area.

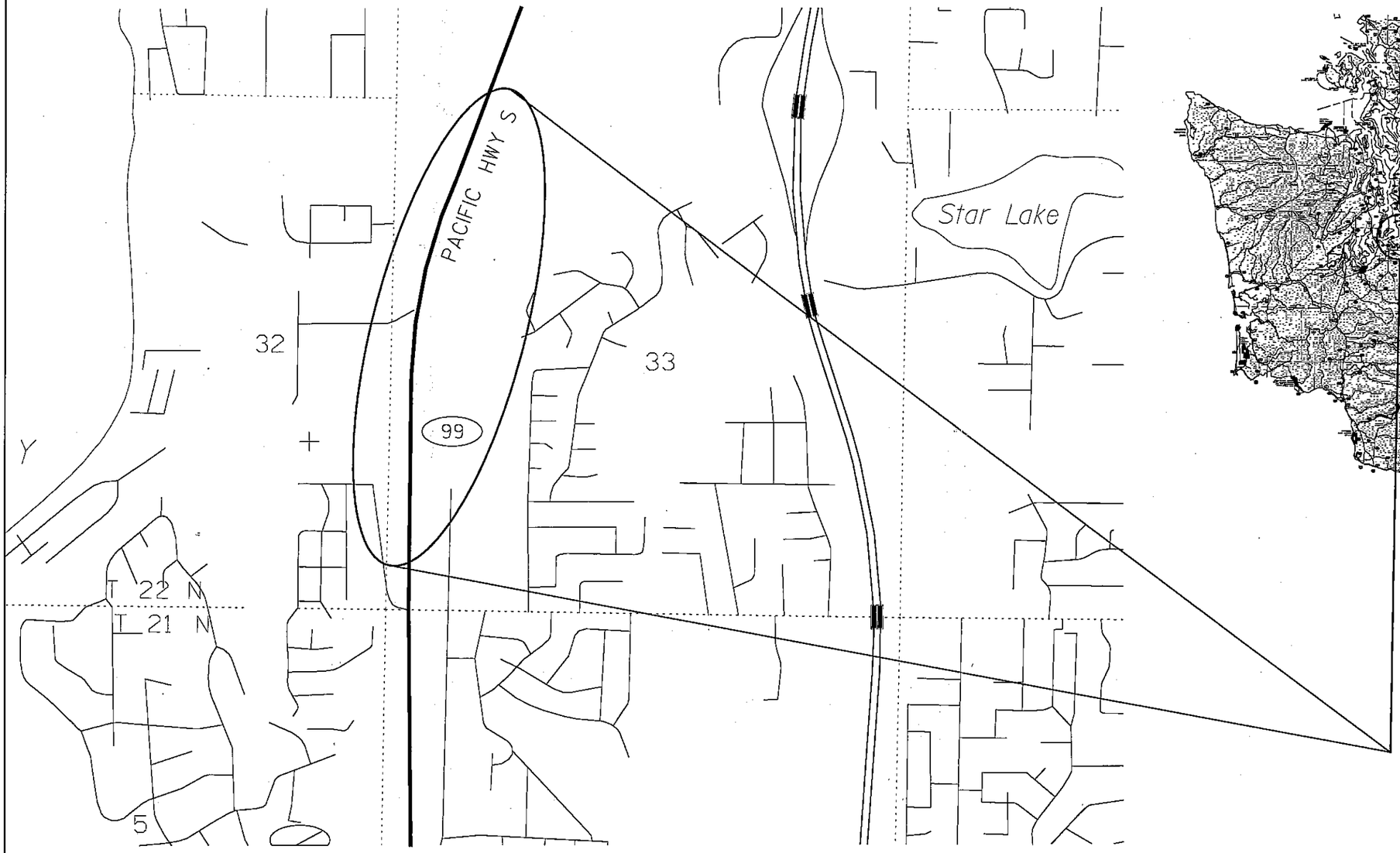
At the cut slope, perched water could occur. Perched water often occurs over silt, or other, relatively impermeable materials, that occur within a glacially deposited material. We would expect the volumes of perched water to be limited. Zones with persistant water, may require the construction of toe and/or trench drains to control the entrance and exit of ground water from the cut slope area.

7. CLOSURE

If you have any questions or require further information, please contact Tony Allen at 360.709.5450 or Todd Mooney at 360.709.5463.

8. REFERENCES

Booth, D.B.; Waldron, H.H. and Toost, K.G. (2004) Geologic Map of the Poverty Bay 7.5′ Quadrangle, King and Pierce Counties, Washington, USGS, Scientific Investigations Map 2854; available at: http://pubs.usgs.gov/sim/2004/2854.



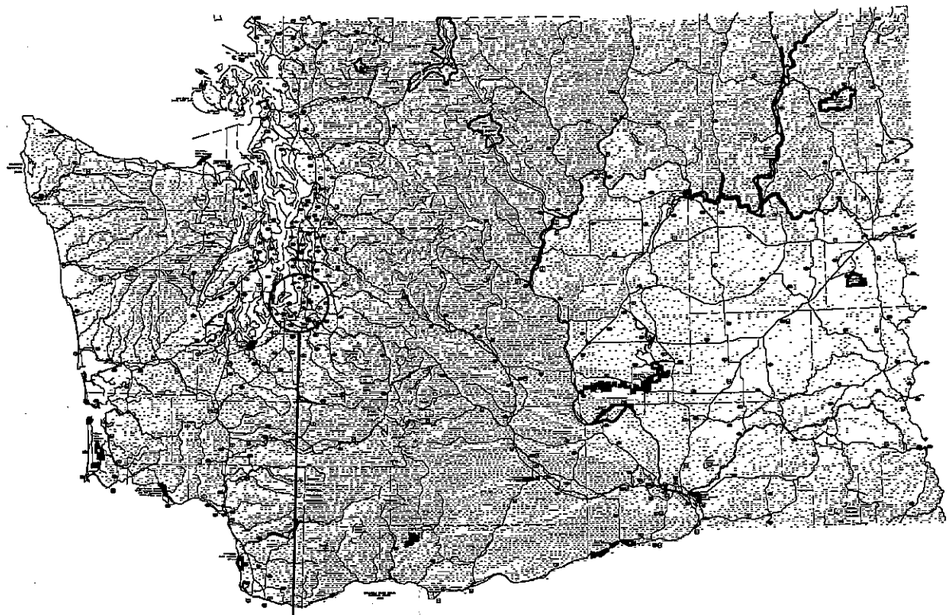


Figure 1: Vicinity Map

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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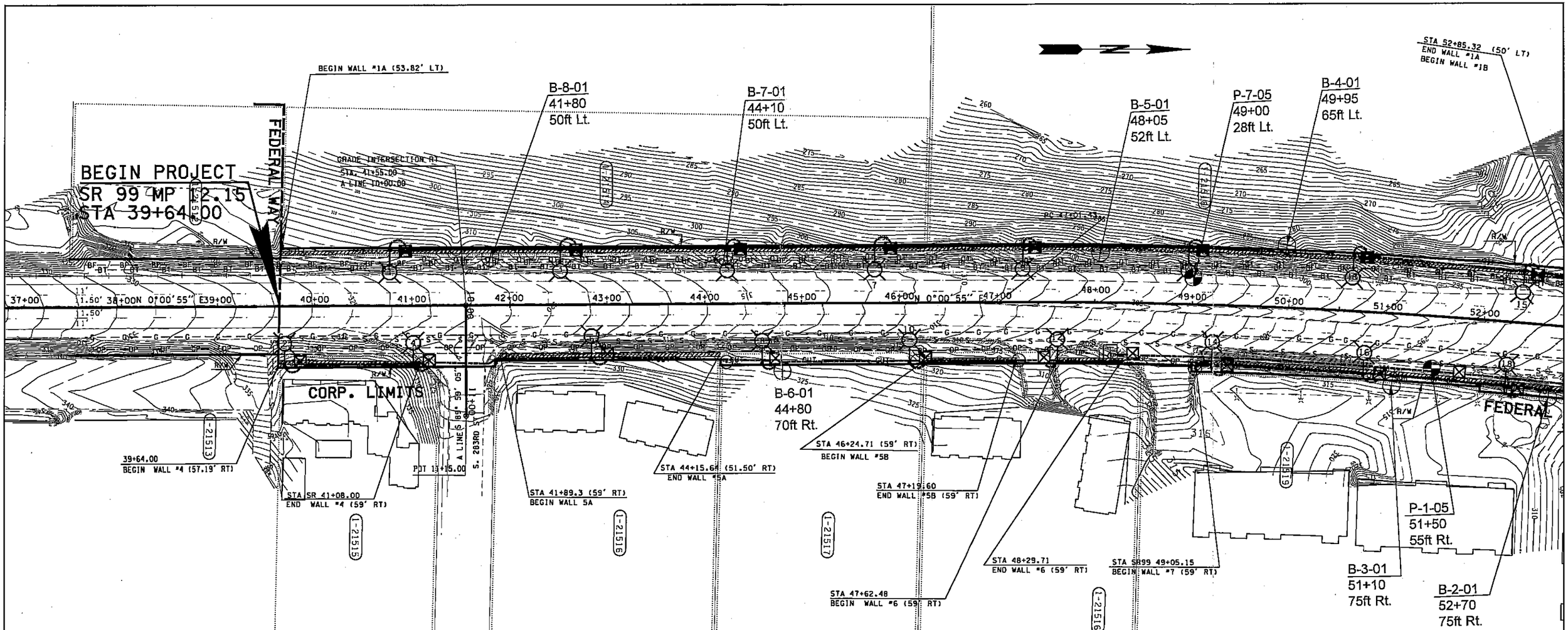

NOTES:

- ⊕ B-XX-O1 Civil-Tech Boring
- ◕ P-XX-O5 WSDOT Boring
- ⊙ Proposed Power Pole Location
- Proposed Luminaire Location

Figure 2:Site Plan and Bore Hole Locations

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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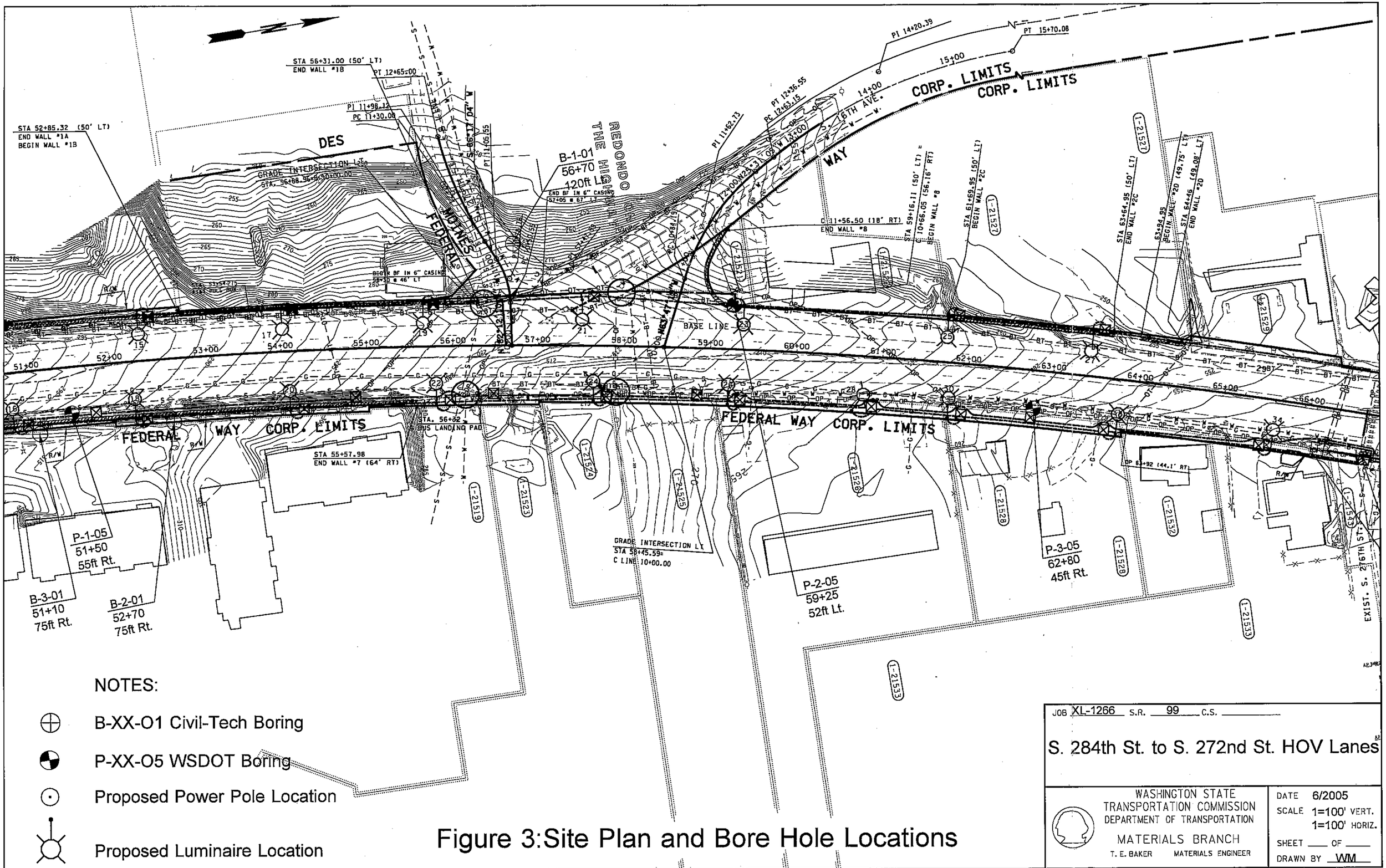

NOTES:

- ⊕ B-XX-O1 Civil-Tech Boring
- ◒ P-XX-O5 WSDOT Boring
- ⊙ Proposed Power Pole Location
- Proposed Luminaire Location

Figure 3:Site Plan and Bore Hole Locations

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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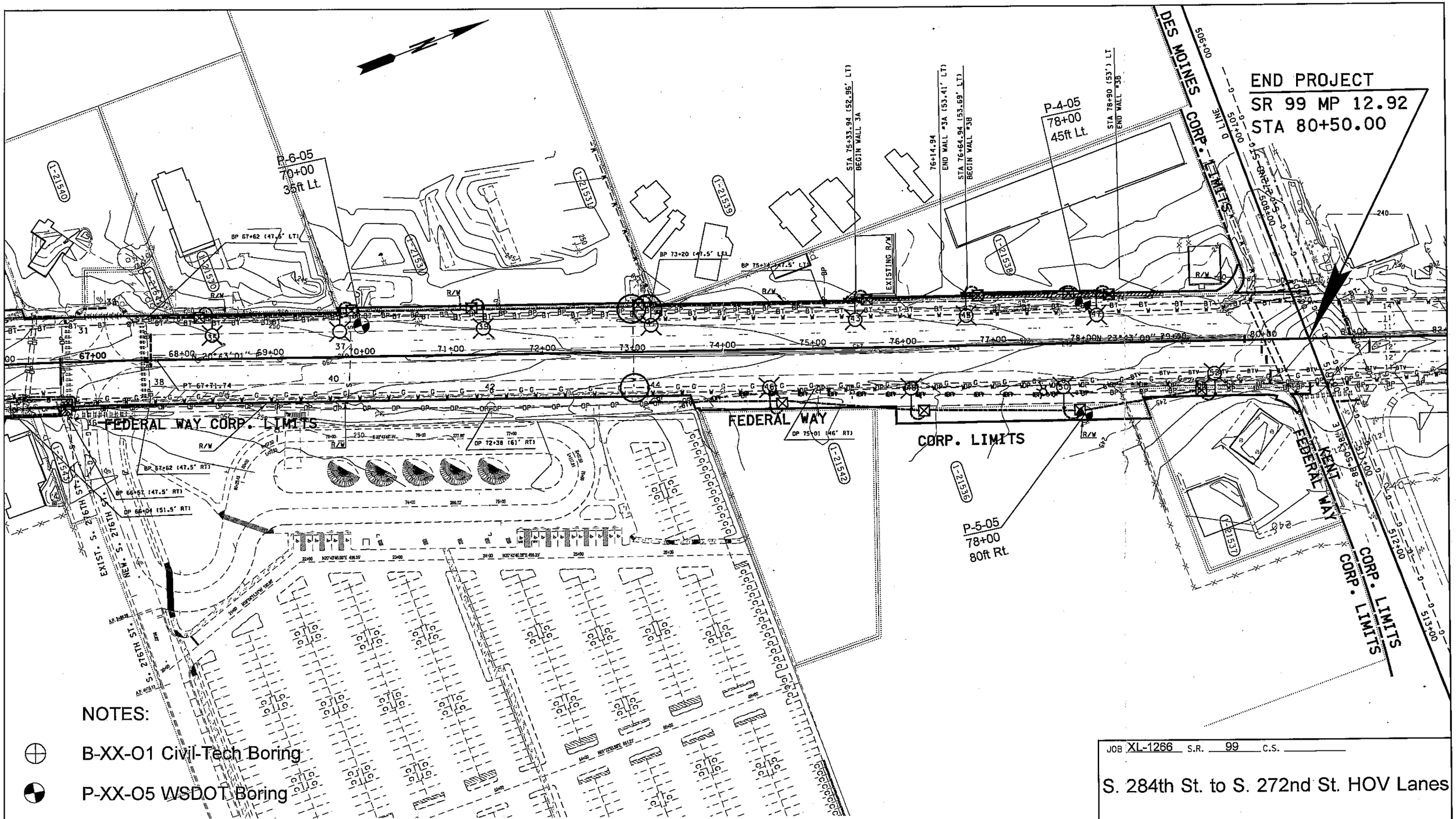

NOTES:

- ⊕ B-XX-O1 Civil-Tech Boring
- ◒ P-XX-O5 WSDOT Boring
- ⊙ Proposed Power Pole Location
- Proposed Luminaire Location

Figure 4:Site Plan and Bore Hole Locations

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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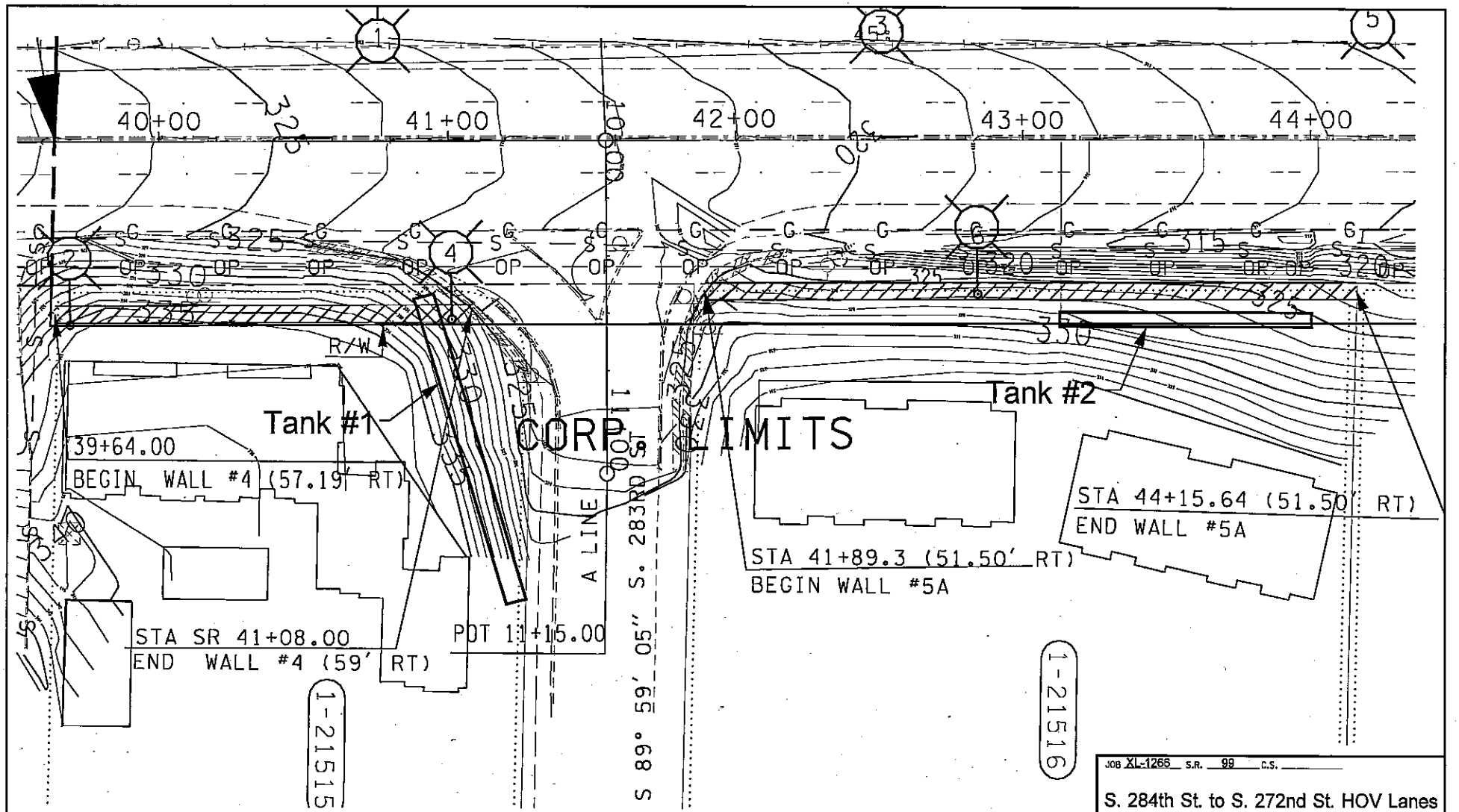

Figure 5: Plan View of Detention Tanks 1 and 2

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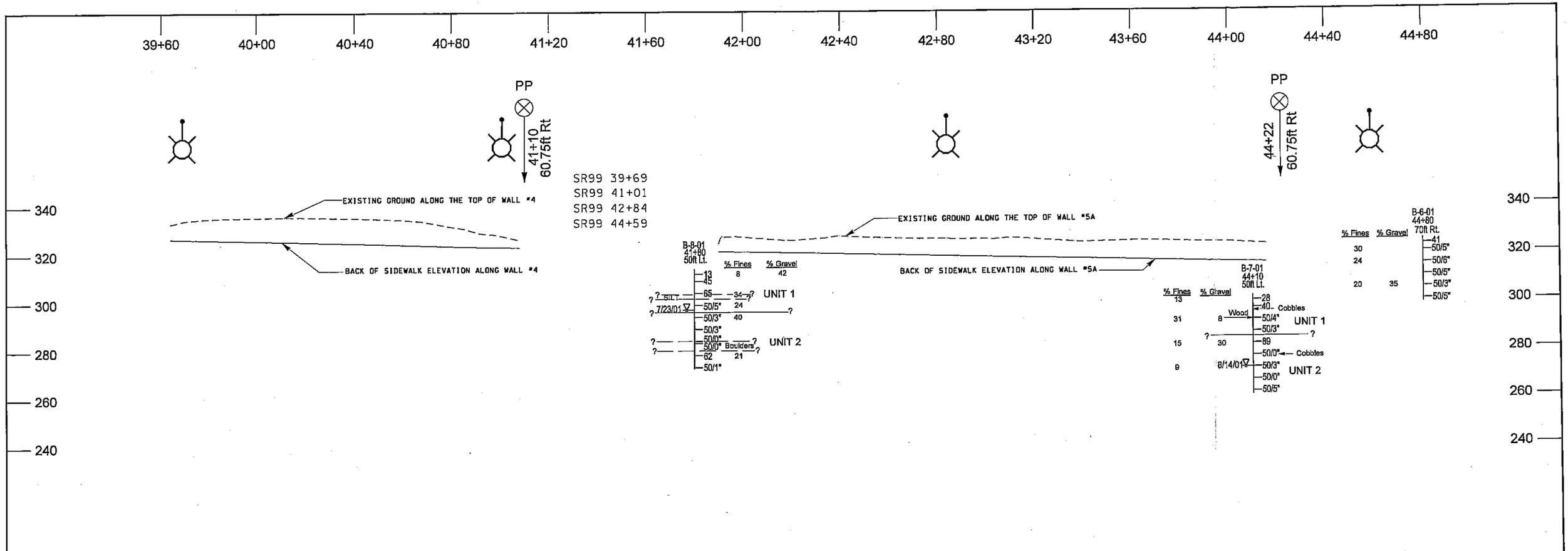

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

H-1-98 TEST HOLE NUMBER
110+55 TEST HOLE STATION
26 ft.Rt. TEST HOLE OFFSET

23 STANDARD PENETROMETER TEST (BLOWS PER FOOT)
UNDISTURBED SAMPLE
W.L. 8-6-86 WATER LEVEL & DATE
? ? INDICATES SOIL/ROCK STRATA BETWEEN TEST HOLES MAY NOT BE CONTINUOUS.
INDICATES INTACT ROCK
86% INDICATES CORE SAMPLE TAKEN
ROCK QUALITY DESIGNATION

PP = Power Pole

Proposed Luminaire Location

Figure 6: Generalized Soil Profile for Wall 4 and Wall 5A

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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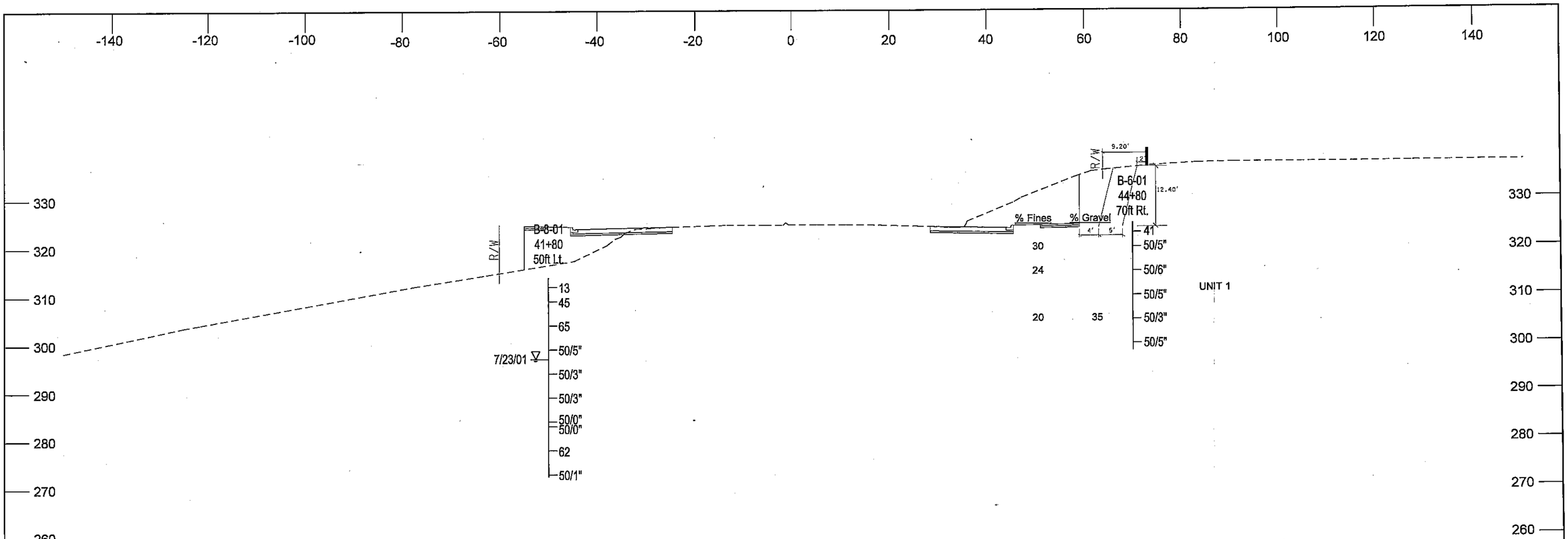

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

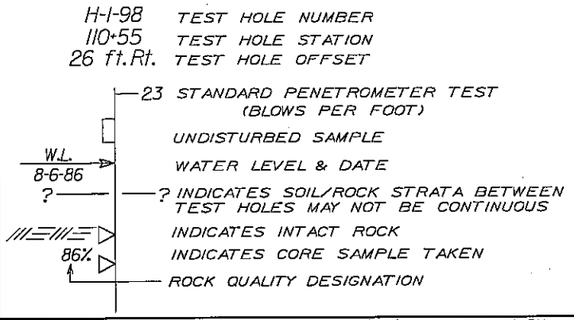

Figure 7: Design Section (40+50) for Walls 4 and 5A

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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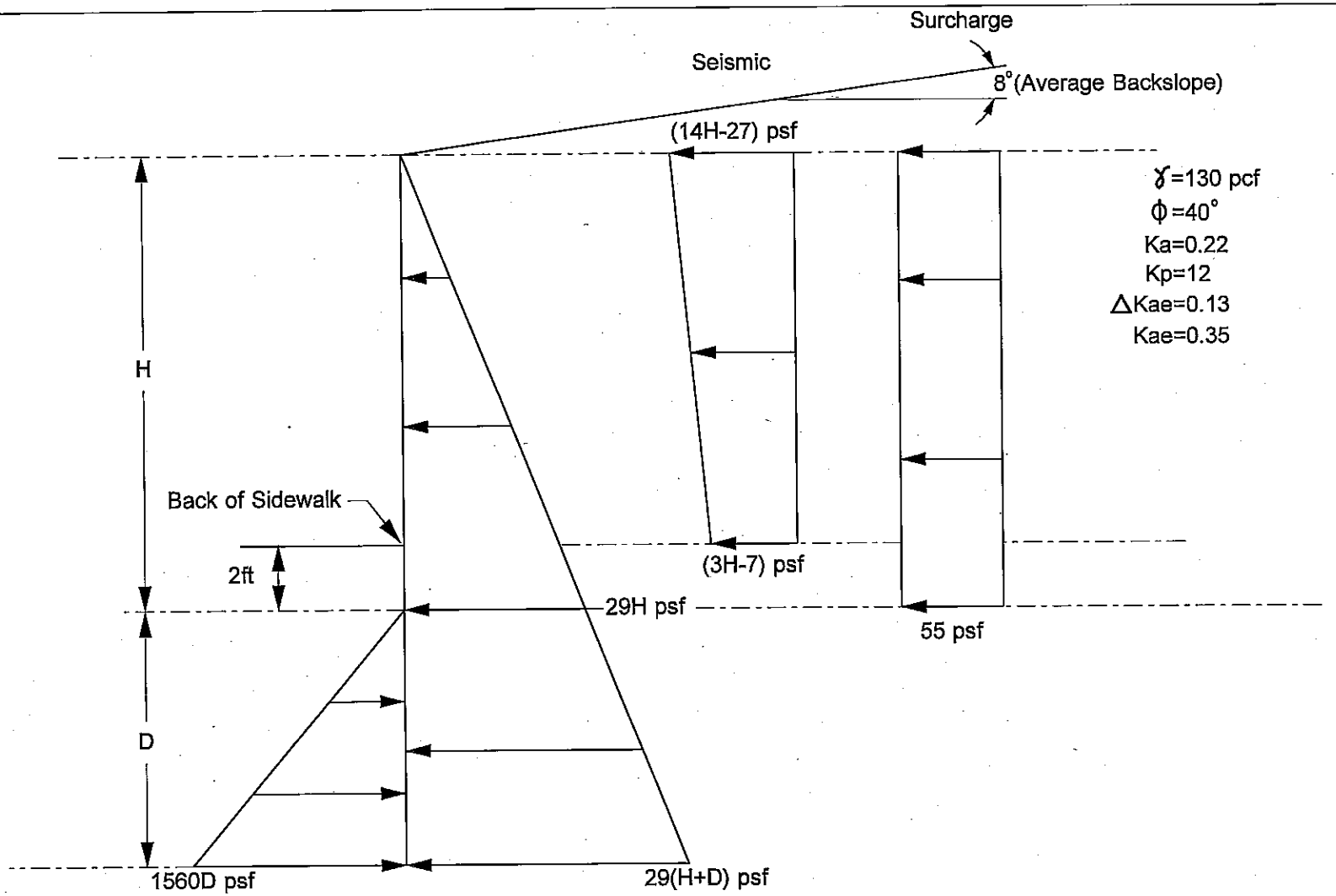

Earth Pressure Diagram Notes

1. All pressure ordinates are in psf. Dimensions of H and D are in feet.
2. Load factors have not been applied to active pressures.
3. Active pressure below bottom of lagging acts over the pile diameter.
4. Active pressure per pile acts over the pile spacing on the lagging.
5. Passive pressure below bottom of lagging acts over 3 times the pile diameter.
6. Passive resistance is not factored. Use a resistance factor of 0.75 for passive resistance for the strength limit state and 1.0 for the service and extreme limit states.

Figure 8: Earth Pressure Diagram for Walls 4 and 5A (Drawn at Sta. 40+50)

JOB XL-1266 S.R. 99 C.S. _____ LAYOUT _____

South 272nd Street to South 284th-HOV

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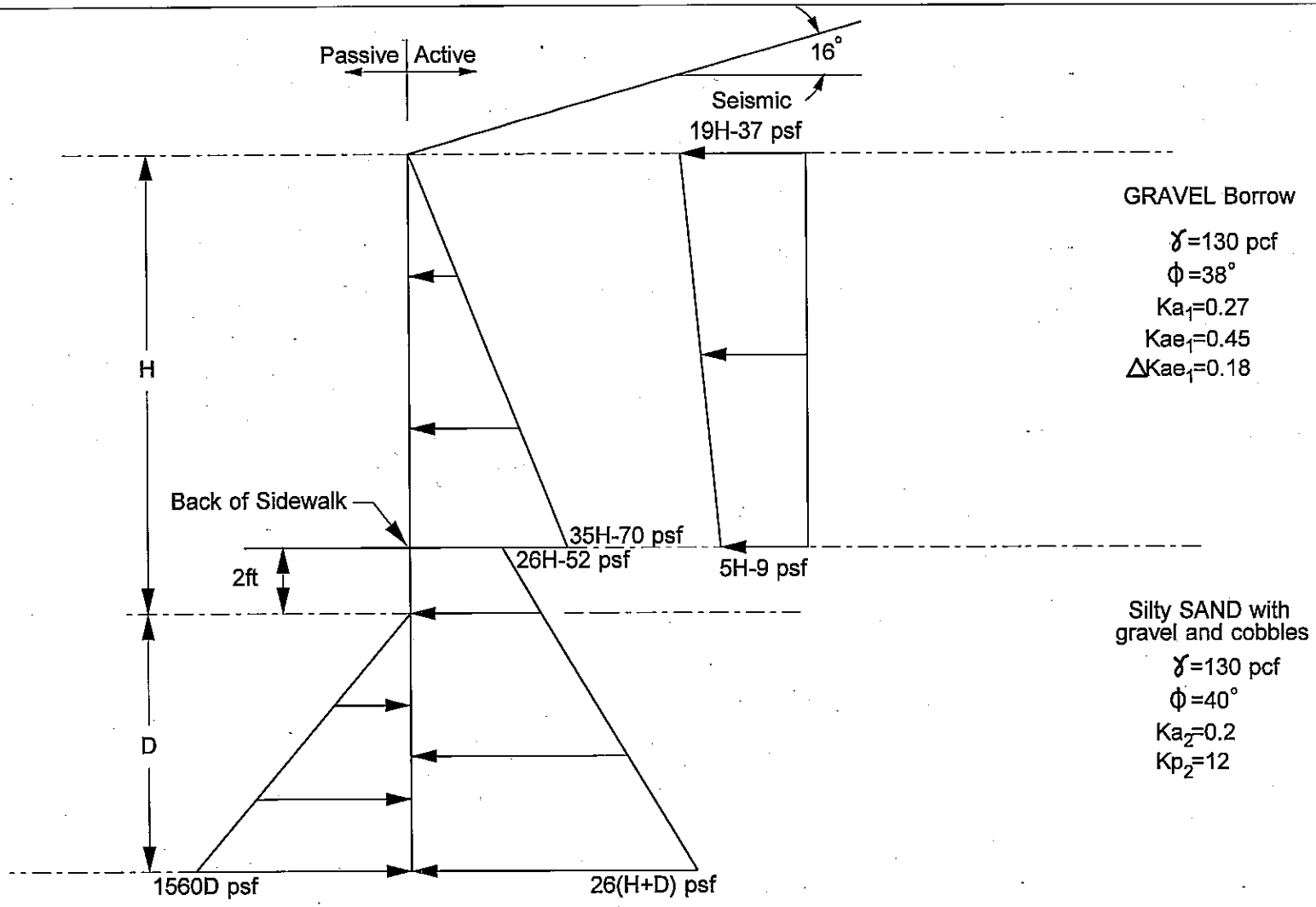

Earth Pressure Diagram Notes

1. All pressure ordinates are in psf. Dimensions of H and D are in feet.
2. Load factors have not been applied to active pressures.
3. Active pressure below bottom of lagging acts over the pile diameter.
4. Active pressure per pile acts over the pile spacing on the lagging.
5. Passive pressure below bottom of lagging acts over 3 times the pile diameter.
6. Passive resistance is not factored. Use a resistance factor of 0.75 for passive resistance for the strength limit state and 1.0 for the service and extreme limit states.

Figure 9: Earth Pressure Diagram for Wall 5A, Sta. 43+08 to End of Wall

JOB XL-1266 S.R. 99 C.S. _____ LAYOUT _____

South 284th Street to South 272nd-HOV

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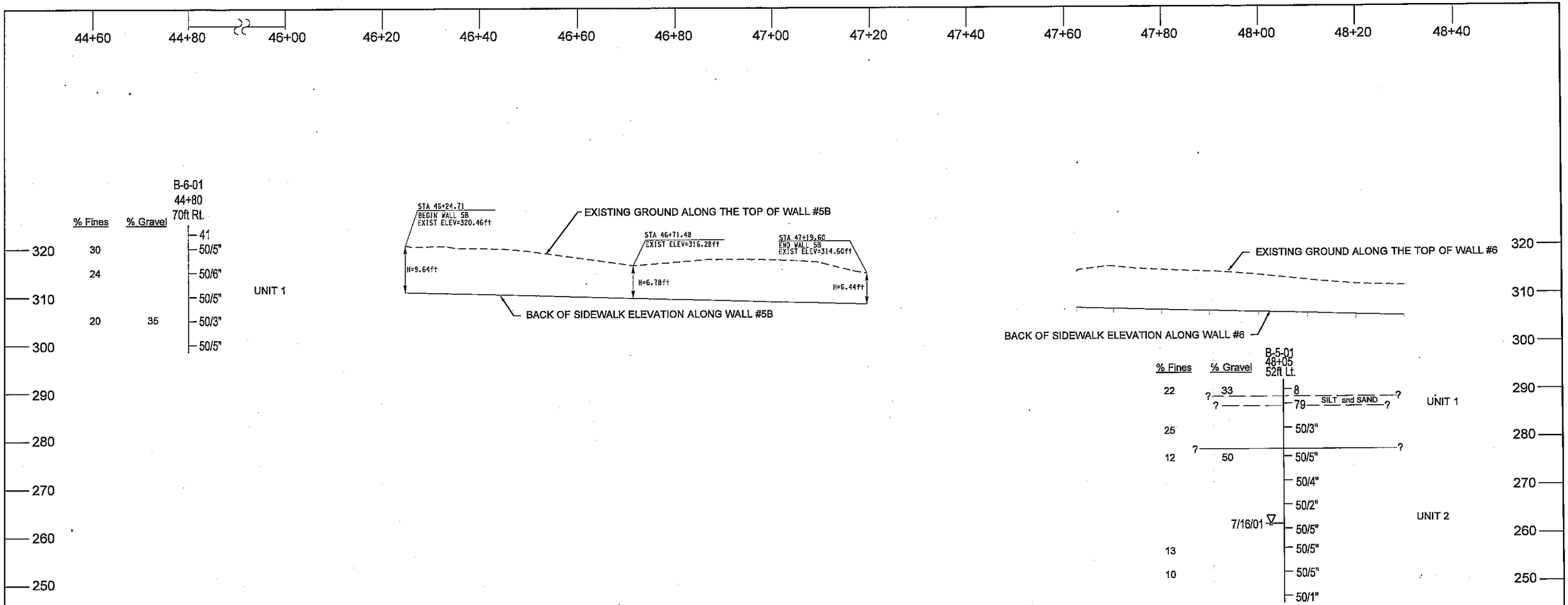

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

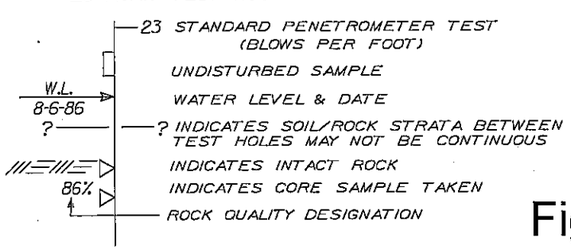

Figure 10: Generalized Soil Profile for Wall 5B and Wall 6

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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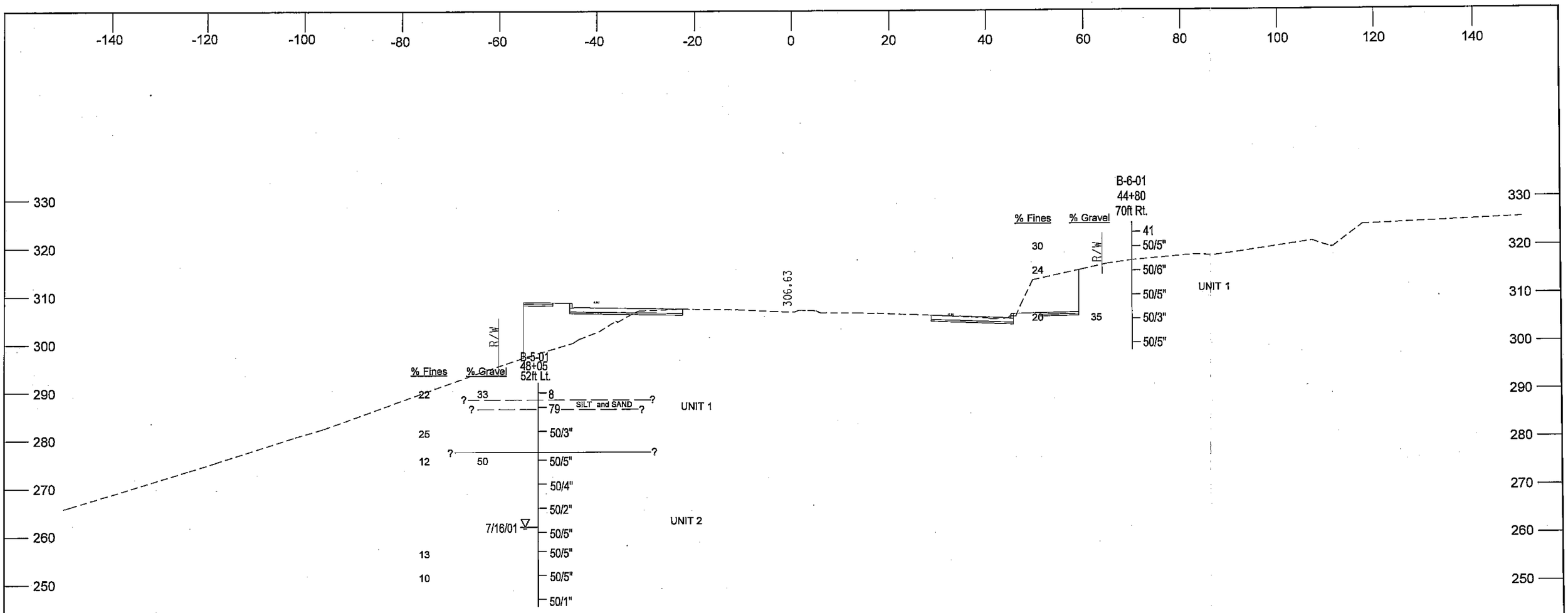

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

H-I-98 TEST HOLE NUMBER
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26 ft. Rt. TEST HOLE OFFSET

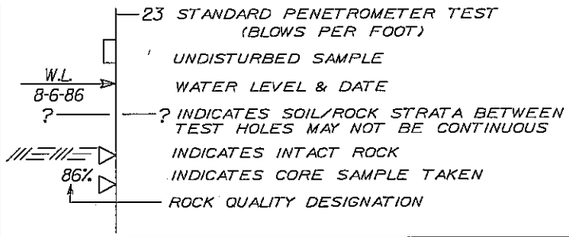

Figure 11: Design Section (47+80) for Walls 5B and 6

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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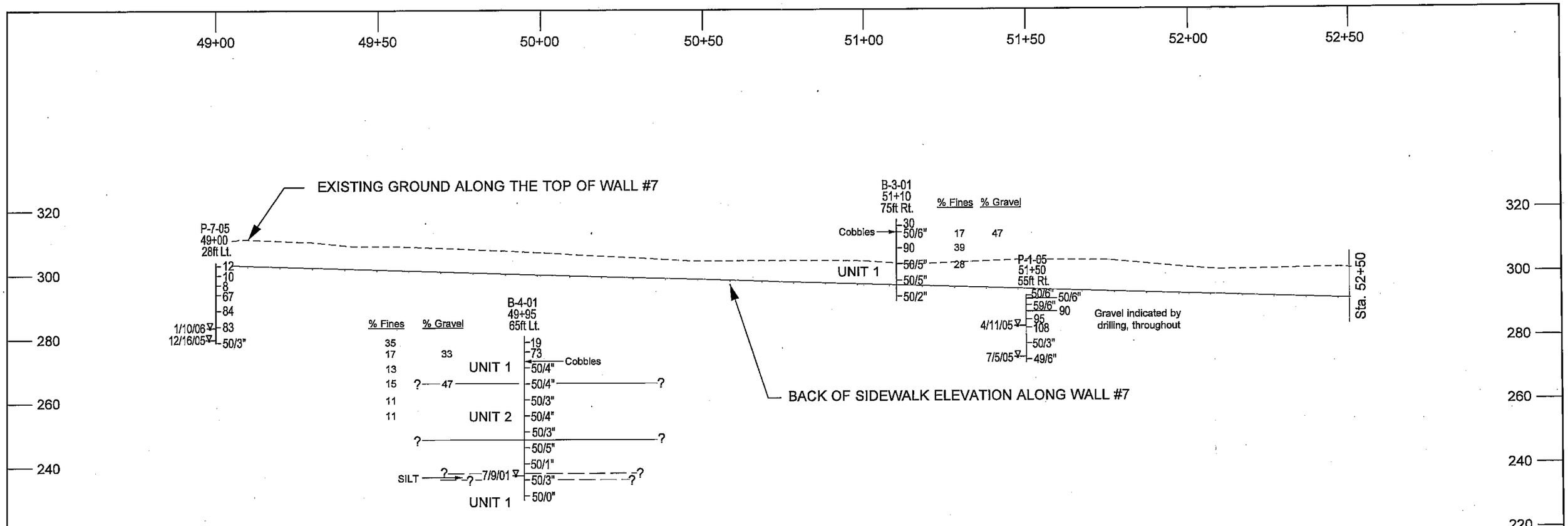
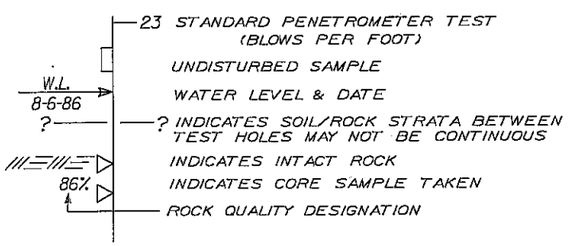


TEST HOLE LEGEND

H-I-98 TEST HOLE NUMBER
110+55 TEST HOLE STATION
26 ft.Rt. TEST HOLE OFFSET



NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 6/2005
SCALE 1=30' VERT. 1=30' HORIZ.
SHEET ___ OF ___
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Figure 12: Generalized Soil Profile for Wall 7 (Sta. 49+05 to 52+50)

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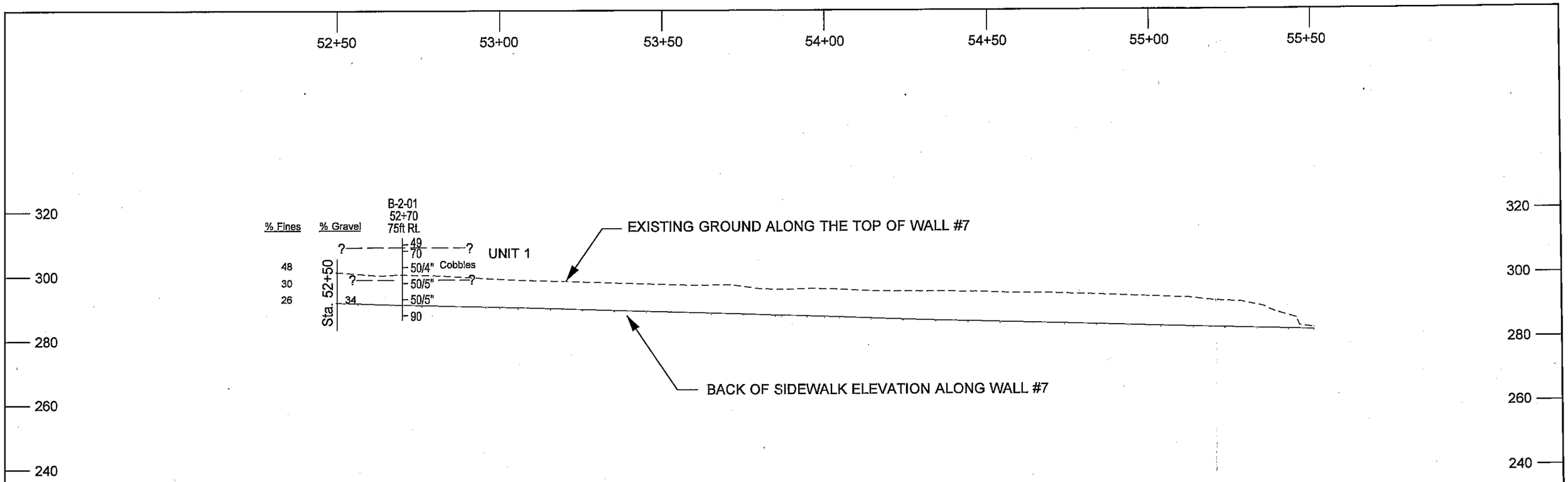

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

H-I-98 TEST HOLE NUMBER
110+55 TEST HOLE STATION
26 ft. Rt. TEST HOLE OFFSET

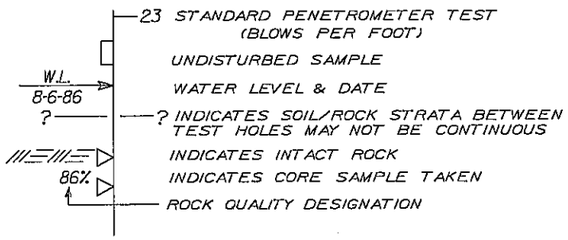

Figure 13: Generalized Soil Profile for Wall 7 (Sta. 52+50 to 55+57.98)

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE
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T. E. BAKER MATERIALS ENGINEER

DATE 6/2005
SCALE 1=30' VERT.
1=30' HORIZ.
SHEET ___ OF ___
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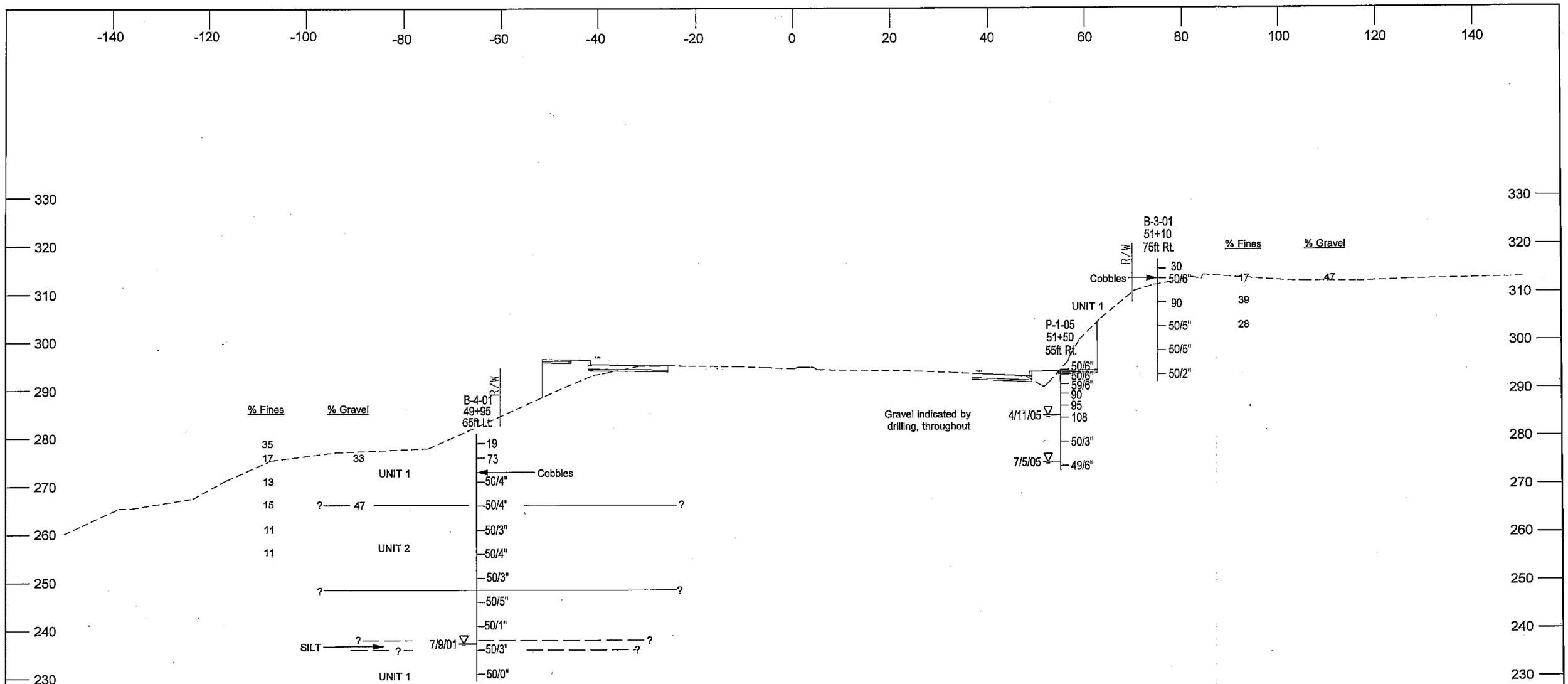

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

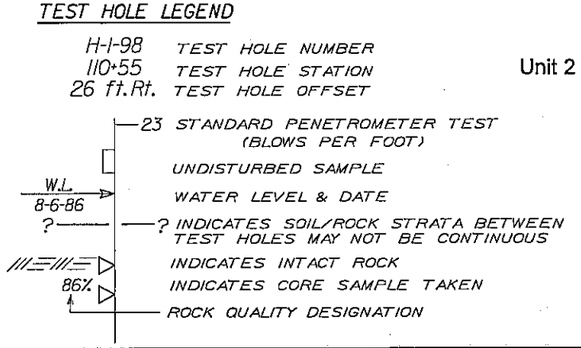

Figure 14: Design Section (51+80) for Wall 7

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE TRANSPORTATION COMMISSION
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MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 9/2005
SCALE 1=20' VERT.
1=20' HORIZ.
SHEET ___ OF ___
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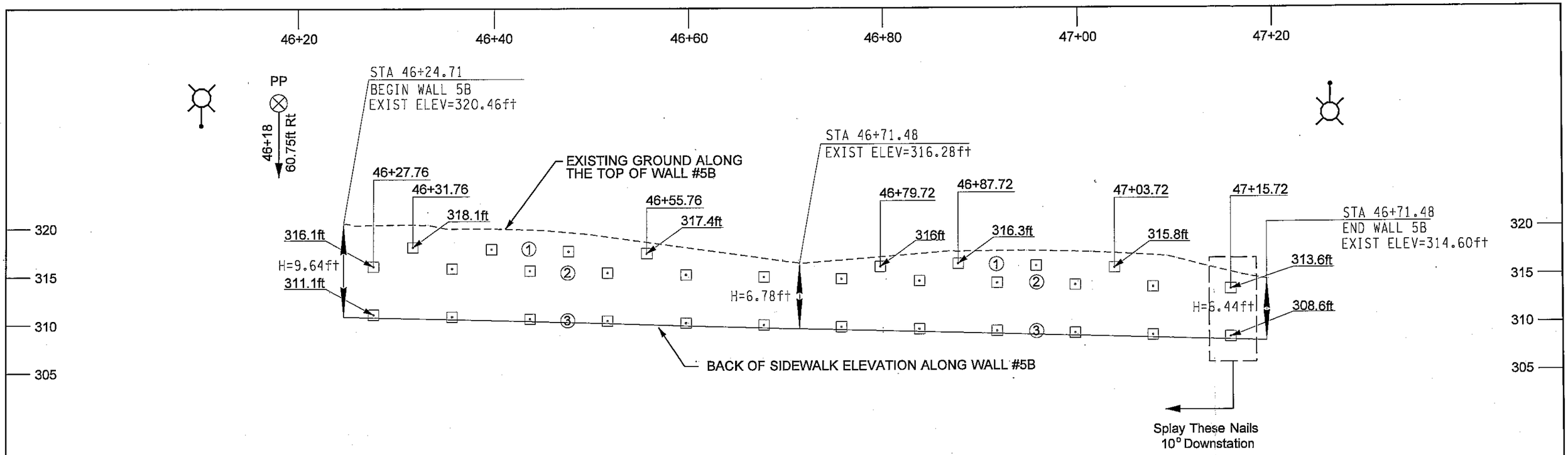

Wall 5B Soil Nail Schedule

Station		Design Load Transfer, DLT (lb/ft)	Nail Inc. (Degrees)	Minimum Nail Length (ft)	Min. Bar #	Row #	Minimum Grout Hole Diameter (in)	Maximum Horizontal Nail Space (ft)
From	To							
46+24.71	47+19.60	1500	15	12	8	All	6	8

PP = Power Pole

Proposed Luminaire Location

Figure 15: Soil Nail Layout and Schedule for Wall 5B

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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DATE 6/2005
SCALE 1=10' VERT.
1=10' HORIZ.
SHEET ___ OF ___
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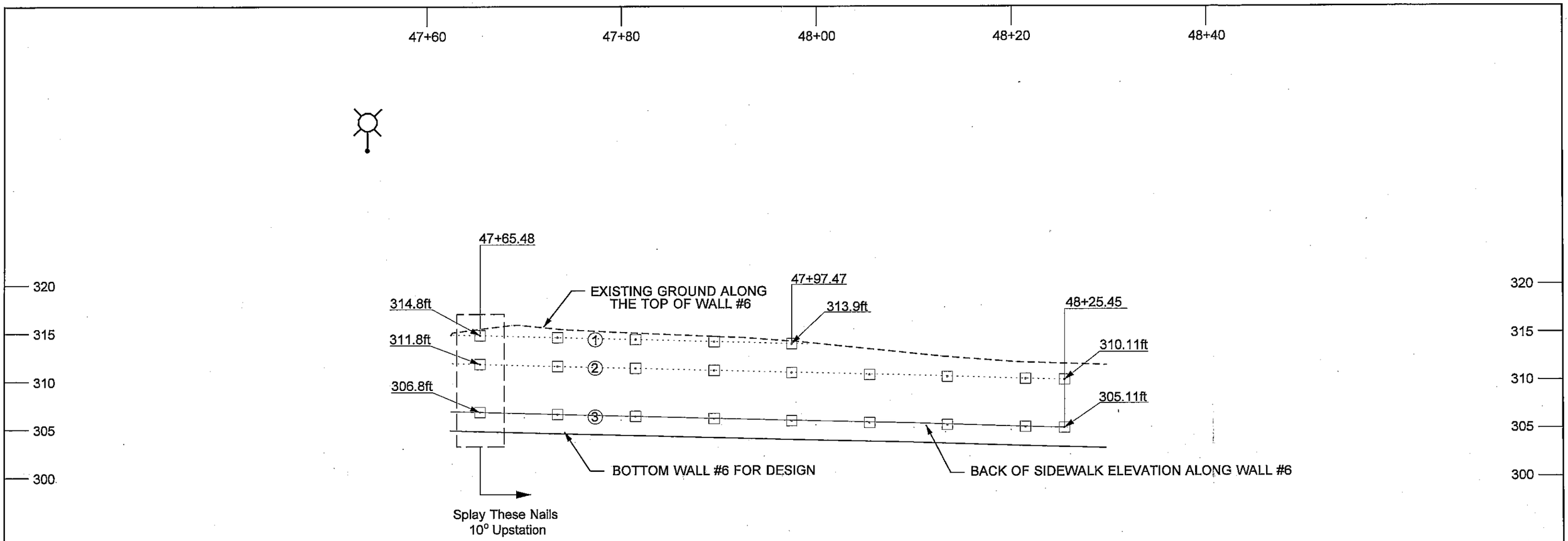

Wall 6 Soil Nail Schedule

Station		Design Load Transfer, DLT (lb/ft)	Nail Inc. (Degrees)	Minimum Nail Length (ft)	Min. Bar #	Row #	Minimum Grout Hole Diameter (in)	Maximum Horizontal Nail Space (ft)
From	To							
47+62.48	48+29.71	1500	15	12	8	All	6	8

Proposed Luminaire Location

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE
TRANSPORTATION COMMISSION
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SCALE 1=10' VERT.
1=10' HORIZ.
SHEET ___ OF ___
DRAWN BY WM

Figure 16: Soil Nail layout and Schedule for Wall 6

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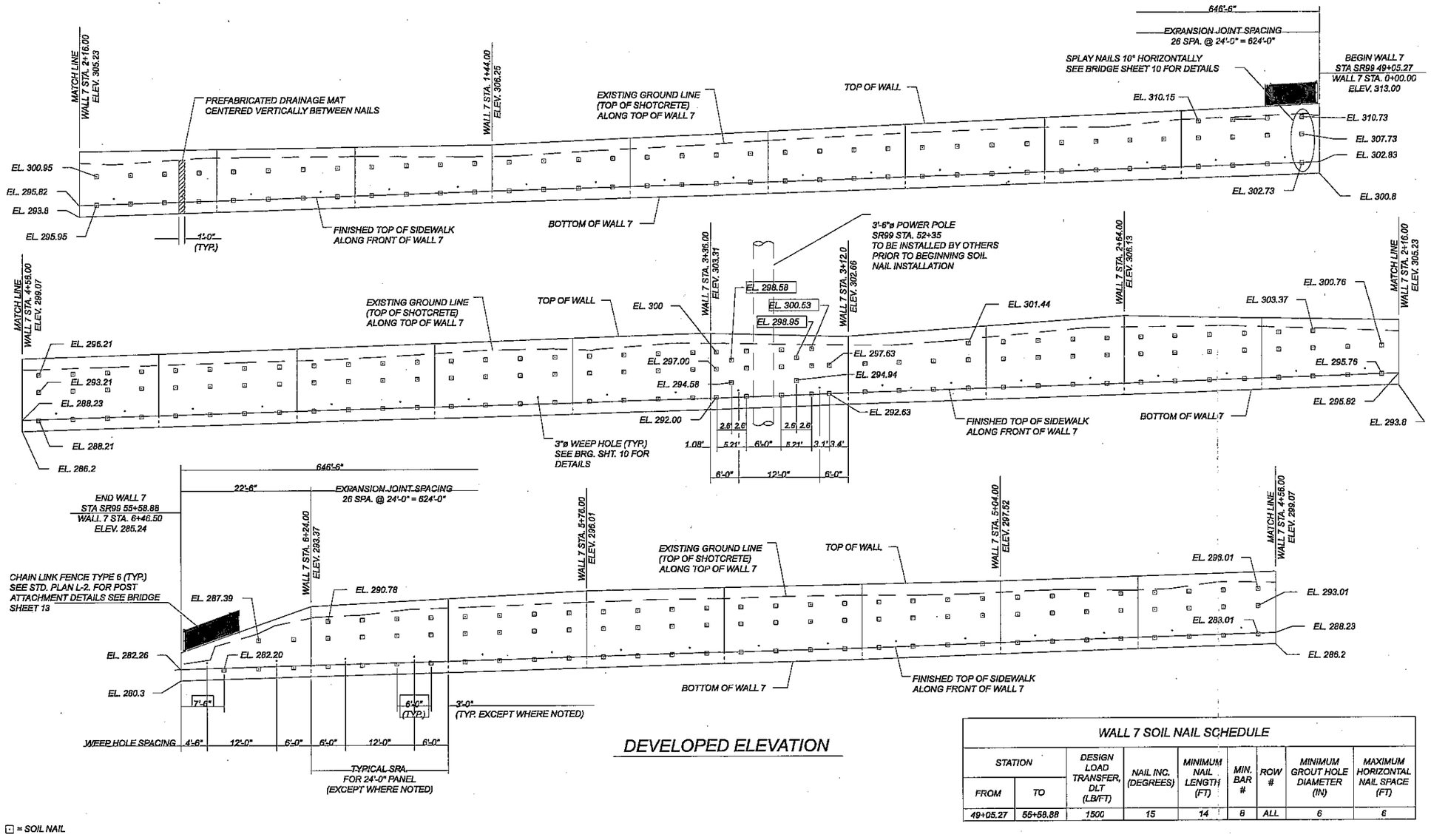

WALL 7 SOIL NAIL SCHEDULE								
STATION		DESIGN LOAD TRANSFER, DLT (LB/FT)	NAIL INC. (DEGREES)	MINIMUM NAIL LENGTH (FT)	MIN. BAR #	ROW #	MINIMUM GROUT HOLE DIAMETER (IN)	MAXIMUM HORIZONTAL NAIL SPACE (FT)
FROM	TO							
49+05.27	55+58.88	1500	15	14	8	ALL	6	6

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

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1=20' HORIZ.
SHEET ___ OF ___
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Figure 17: Soil Nail Layout and Schedule for Wall 7

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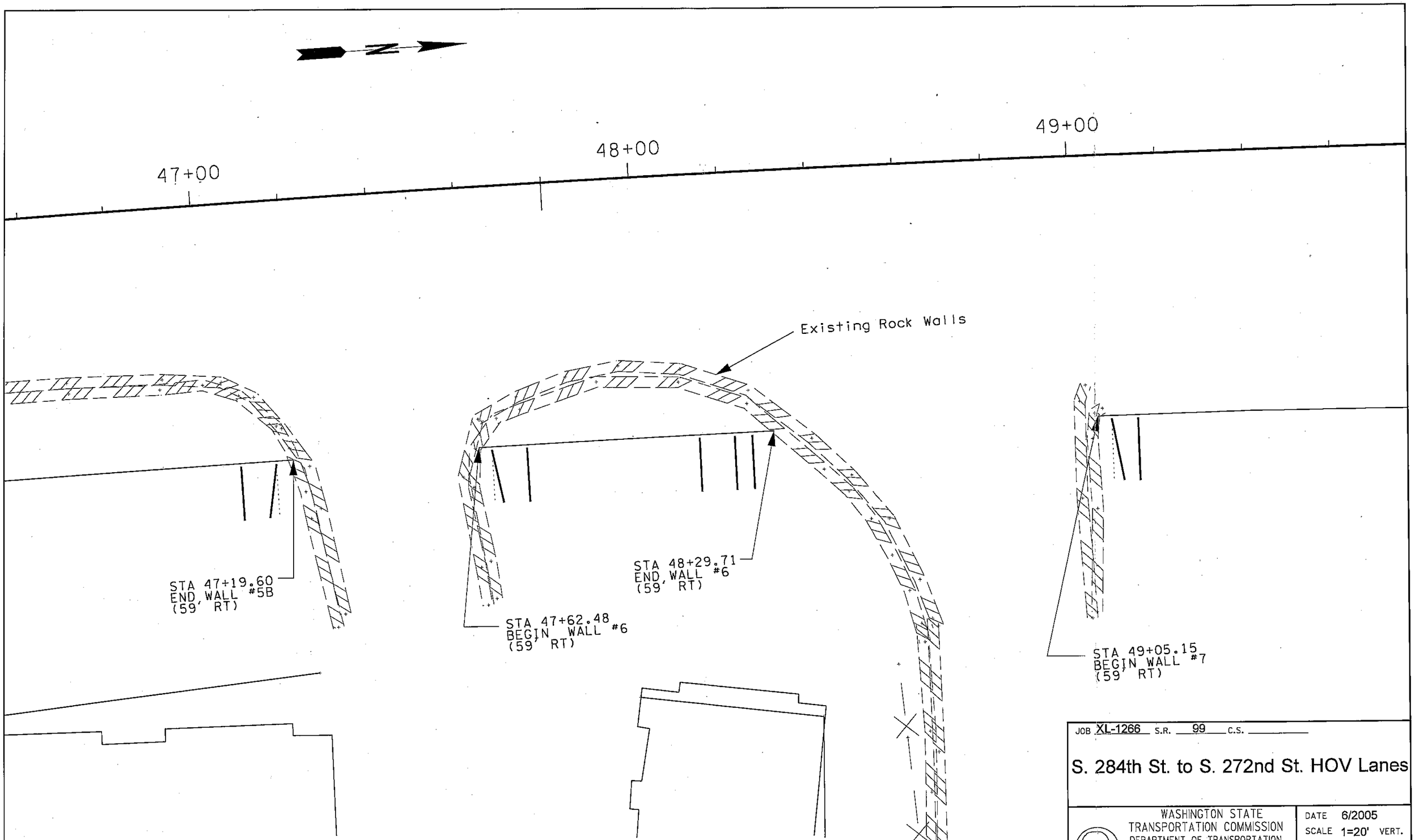

Figure 18: Plan View of Splayed Nails, Walls 5B, 6 and 7

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE
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DATE 6/2005
SCALE 1=20' VERT.
1=20' HORIZ.
SHEET ___ OF ___
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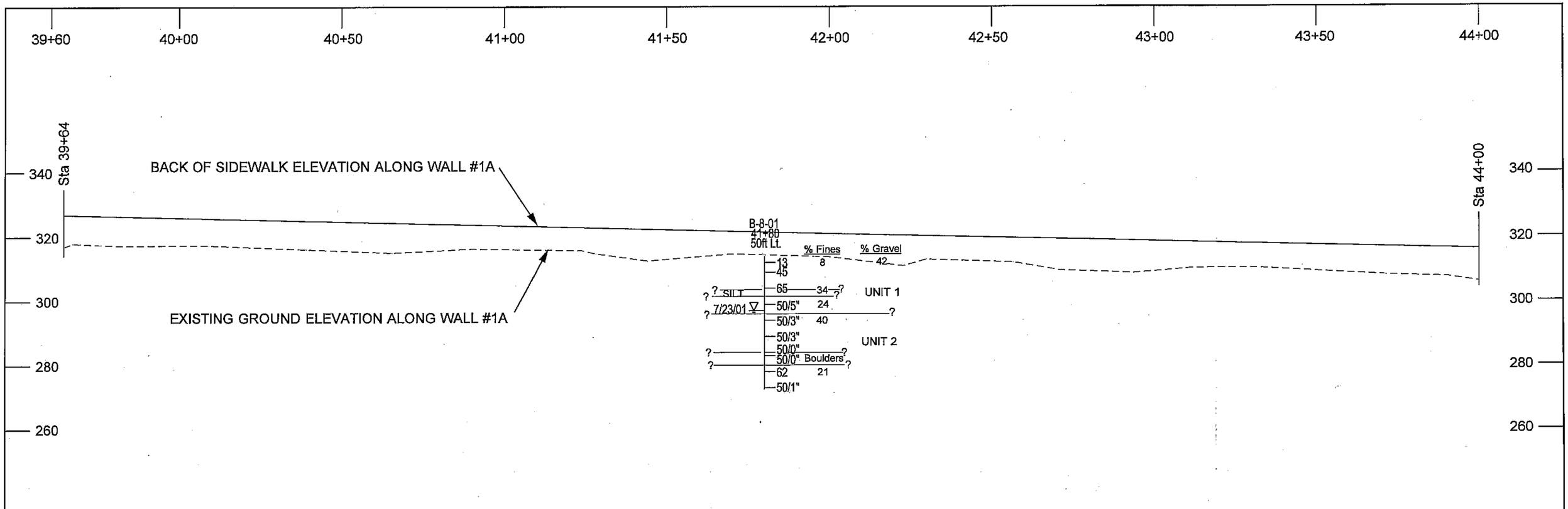

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

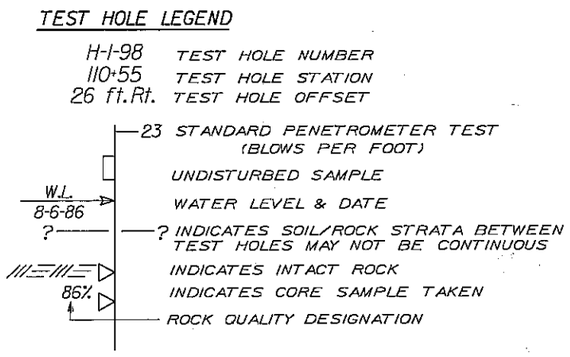

Figure 19: Generalized Soil Profile for Wall 1A (Sta. 39+64 to 44+00)

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE TRANSPORTATION COMMISSION
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MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 6/2005
SCALE 1=30' VERT.
1=30' HORIZ.
SHEET ___ OF ___
DRAWN BY WM

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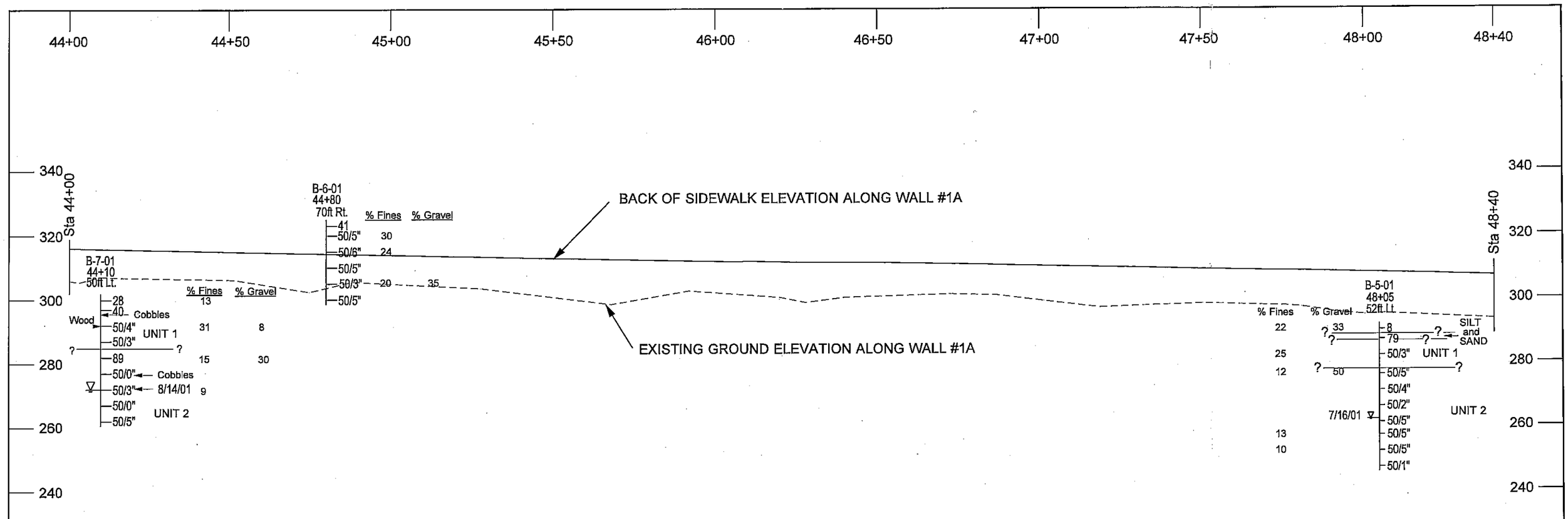

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

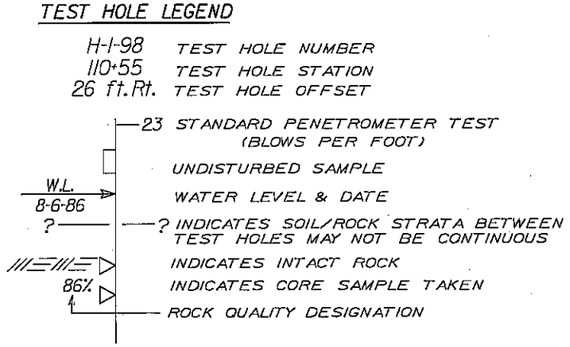

Figure 20: Generalized Soil Profile for Wall 1A (Sta. 44+00 to 48+40)

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 6/2005
SCALE 1=30' VERT. 1=30' HORIZ.
SHEET ___ OF ___
DRAWN BY WM

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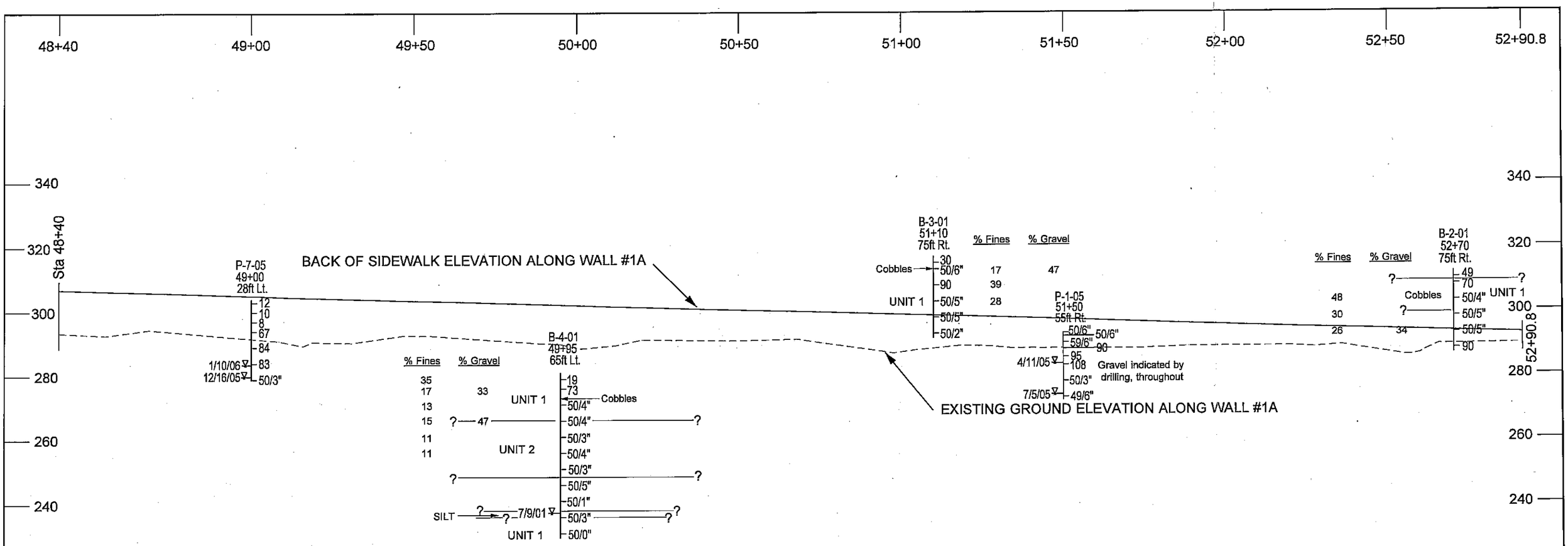

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

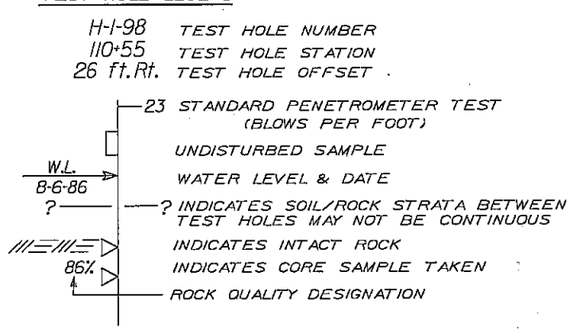

Figure 21: Generalized Soil Profile for Wall 1A(Sta. 48+40 to 52+90.8)

JOB XL-1266 S.R. 99 C.S. _____

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 6/2005
SCALE 1=30' VERT. 1=30' HORIZ.
SHEET ___ OF ___
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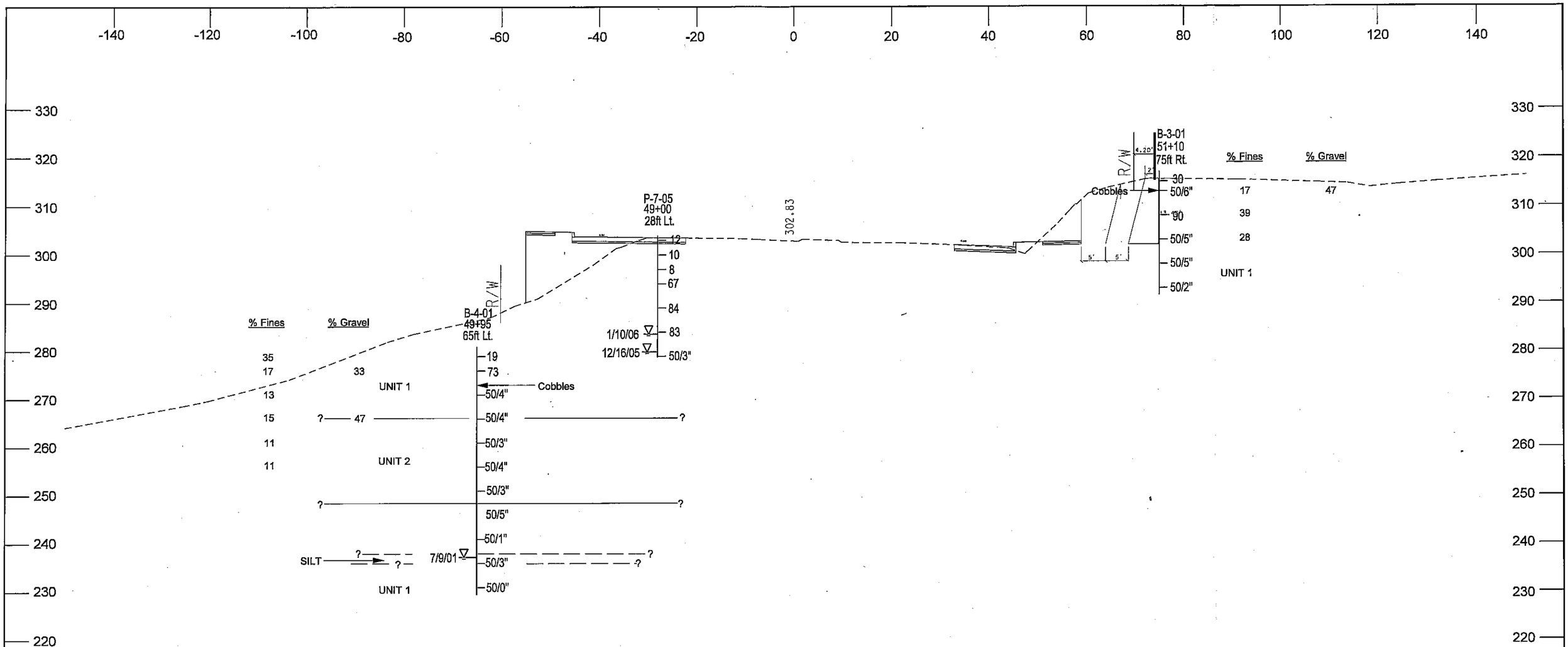

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

H-I-98 TEST HOLE NUMBER
110+55 TEST HOLE STATION
26 ft.Rt. TEST HOLE OFFSET

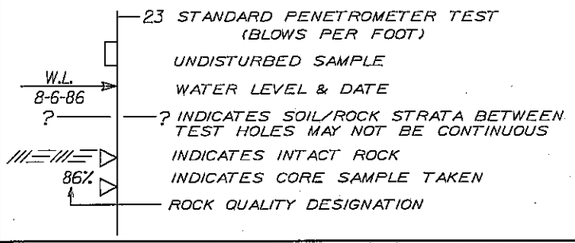

Figure 22: Wall 1A Soil Profile at Sta. 49+10

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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T. E. BAKER MATERIALS ENGINEER

DATE 9/2005
SCALE 1=20' VERT.
1=20' HORIZ.
SHEET ___ OF ___
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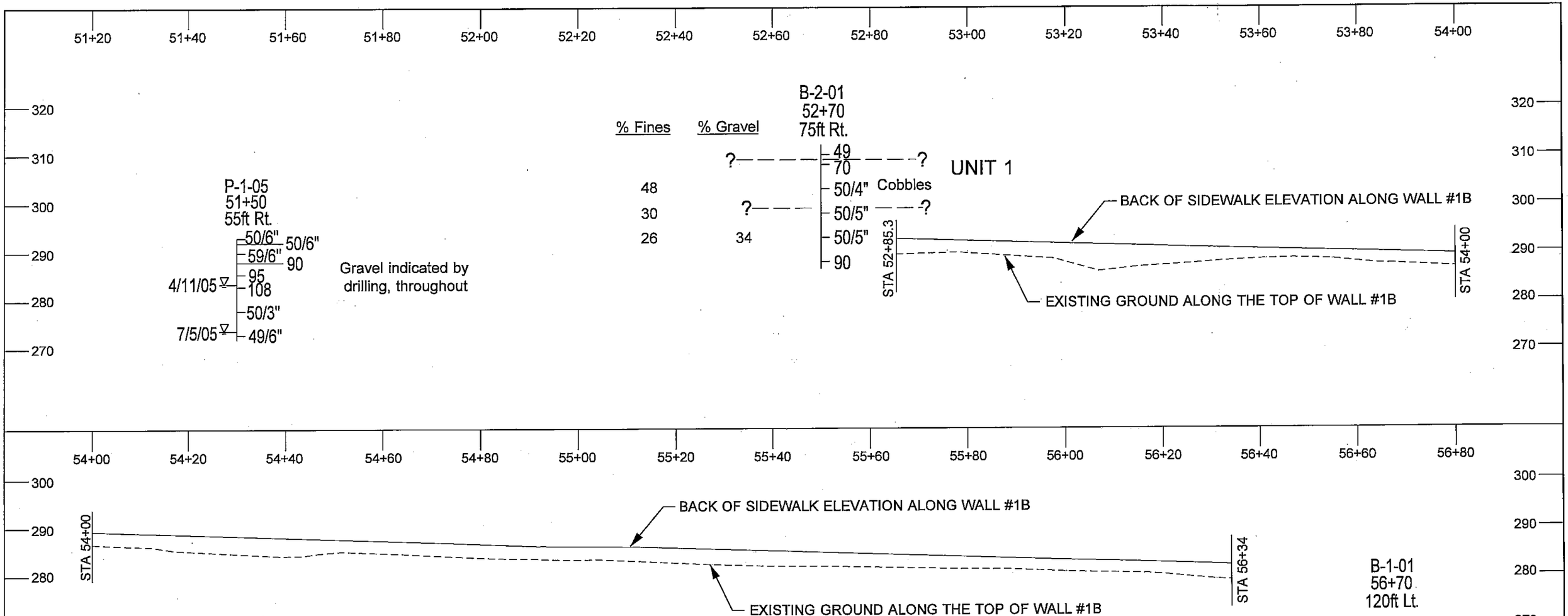

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobbler rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobbles rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

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110+55 TEST HOLE STATION
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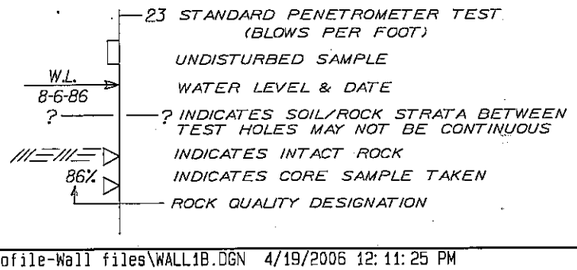

Figure 23: Generalized Soil Profile for Wall 1B

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
T. E. BAKER STATE MATERIALS ENGINEER

DATE 9/2005
SCALE 1=20' VERT.
1=20' HORIZ.
SHEET ___ OF ___
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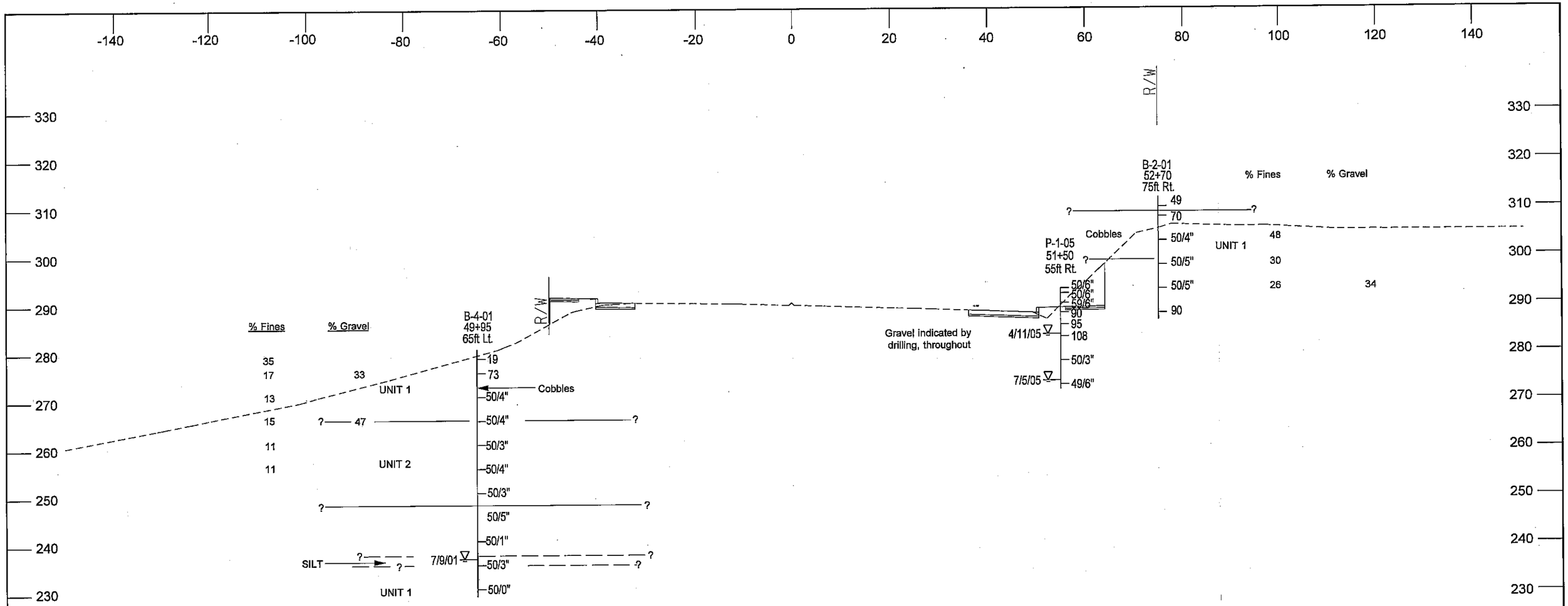

NOTES:

Unit 1 - Silty Sand with Gravel: Unit 1 is interpreted as glacial till. Unit 1 occurs in all the borings; it is separated by Unit 2 in B-4-01. The average fines content is 26 percent, and the average gravel content is about 33 percent. Within Unit 1 there are silt layers and cobble rich layers. Silt layers were noted in borings B-4-01, B-5-01 and B-8-01. Cobble rich layers were noted in borings B-2-01, B-3-01, B-4-01 and B-7-01.

Unit 2 - Sand and Gravel with Cobbles: Unit 2 is interpreted as being glacial outwash. Unit 2 occurs in B-4-01, B-5-01, B-7-01 and B-8-01. In B-4-01, Unit 2 occurs within Unit 1. The average fines content of Unit 2 is 13 percent, and the gravel content ranges from 30 to 47 percent. Within Unit 2 there are cobble and boulder rich layers. Cobbles were noted in B-7-01 and B-8-01. A 4 ft thick zone of boulders was noted in B-8-01.

TEST HOLE LEGEND

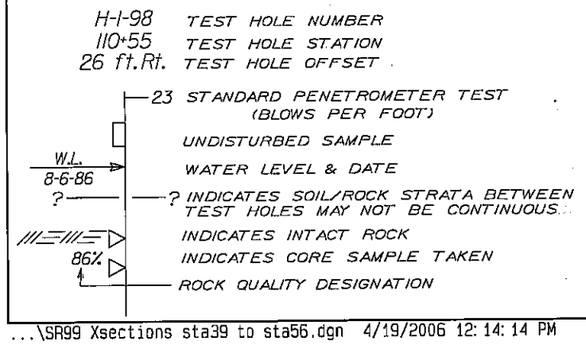

Figure 24: Wall 1B Soil Profile at Sta. 53+30

JOB XL-1266 S.R. 99 C.S.

S. 284th St. to S. 272nd St. HOV Lanes

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T. E. BAKER MATERIALS ENGINEER

DATE 9/2005
SCALE 1=20' VERT.
1=20' HORIZ.
SHEET ___ OF ___
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APPENDIX A: Boring Logs

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-1-01

Job No. XL-1266 SR 99 Elevation 269.0 ft (82.0 m)

Sheet 1 of 2

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start June 26, 2001 Completion June 27, 2001 Well ID# _____

Equipment CME 45 Skid

Station 56+70 Offset 120ft Lt. Casing _____

Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 6in SOD/TOPSOIL		
				12		D-1		Medium dense, moist, dark brown, gravelly, silty SAND		
	1			5		D-2		Loose, damp, tan gray, gravelly, silty SAND, (Weathered till)		
5										
	2			26		D-3	GS MC	SM, MC=12% Medium dense, moist, tan gray, silty, gravelly SAND, (Weathered till)		
10	3									
	4		>>	51		D-4		Very dense, moist, tan gray, silty, gravelly SAND, (Advance Outwash)	▽ 6/27/01	
15	5									
				50/4"		D-5		Increasing gravel, decreasing silt		
20	6									

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:06:32 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-1-01

Job No. XL-1266 SR 99 Elevation 269.0 ft (82.0 m)

Sheet 2 of 2

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
25	7			50/4"		D-6		Increasing silt, decreasing gravel		
	8			50/4"		D-7		Becomes moist to wet, and grayish brown		
30	9							End of test hole boring at 29.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
35	10									
	11									
40	12									
	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05 2:06:32 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-2-01

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation 312.0 ft (95.1 m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Site Address _____ Inspector _____

Start August 7, 2001 Completion August 7, 2001 Well ID# _____ Equipment CME 45 Skid

Station 52+70 Offset 75ft Rt. Casing _____ Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 6in SOD/TOPSOIL		
				49		D-1		Medium dense, moist, grayish-brown, gravelly, silty SAND, (Weathered till)		
5	1		>>	70		D-2		Very dense, moist, tan-gray, gravelly SAND and silt with some cobbles, (Glacial Till)		
10	2 3			50/4"		D-3				
15	4 5			50/5"		D-4		Very dense, moist, tan-gray, silty SAND and gravel, (Glacial Till)		
20	6			50/5"		D-5	GS MC	SM, MC=10%		

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06 1:30:51 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-2-01

Job No. XL-1266 SR 99 Elevation 312.0 ft (95.1 m)

Sheet 2 of 2

Project SR-99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
25	7		>>	90		D-6				
	8							End of test hole boring at 25.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
30	9									
	10									
35	11									
	12									
40	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06,1:30:51 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-3-01

Job No. XL-1266 SR 99 Elevation 317.0 ft (96.6 m)

Sheet 1 of 2

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Site Address _____ Inspector _____

Start August 8, 2001 Completion August 8, 2001 Well ID# _____ Equipment CME 45 Skid

Station 51+10 Offset 75ft Rt. Casing _____ Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 6in SOD/TOPSOIL		
				30		D-1		Medium dense, moist, grayish-brown, gravelly, silty SAND with trace organics, (Weathered till)		
	1			50/6"		D-2	GS MC	SM, MC=14% Very dense, moist, brownish gray, silty, SAND and gravel with some cobbles, (Glacial Till)		
5										
	2									
				>> 90		D-3		Increasing silt		
10	3									
	4			50/5"		D-4		Becomes gray		
15										
	5									
				50/5"		D-5				
20	6									

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06 1:30:54 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-3-01

Job No. XL-1266 SR 99 Elevation 317.0 ft (96.6 m)

Sheet 2 of 2

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
25	7			50/2"		D-6		Blowcount overstated, Pounding on rock		
	8							End of test hole boring at 25.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
30	9									
	10									
35	11									
	12									
40	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06 1:30:55 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-4-01

Job No. XL-1266 SR 99 Elevation 281.0 ft (85.6 m)

Sheet 1 of 3

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Site Address _____ Inspector _____

Start July 2, 2001 Completion July 9, 2001 Well ID# _____ Equipment CME 45 Skid

Station 49+95 Offset 65ft Lt. Casing _____ Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 8-12in SOD/TOPSOIL		
	1			19		D-1		Medium dense, moist to damp, tan gray, fine SAND and silt with some gravel, (Weathered Till) Becomes gravelly		
5			>>	73		D-2	GS MC	SM, MC=11% Very dense, moist, tan, silty SAND and gravel, (Glacial Till)		
	2									
	3									
10				50/4"		D-3		Very dense, moist, tan gray, silty, gravelly SAND with some cobbles, (Glacial Till) At 11-11.5ft; Difficult drilling		
	4									
15				50/4"		D-4	GS MC	SM, MC=9% Very dense, moist, tan gray, silty GRAVEL and sand, (Advance Outwash)		
	5									
	6									
20										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/05 1:30:56 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-4-01

Job No. XL-1266 SR 99 Elevation 281.0 ft (85.6 m)

Sheet 2 of 3

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/3"		D-5		Very dense, moist, tan gray, gravelly, silty SAND, (Advance Outwash)		
	7									
25				50/4"		D-6				
	8									
	9									
30				50/3"		D-7		No Recovery		
	10									
35				50/5"		D-8		Very dense, moist, tan, silty SAND and gravel, (Glacial Till)		
	11									
	12									
40				50/1"		D-9		No Recovery		
	13									
45									7/9/01 ▽	

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06 1:30:56 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-4-01

Job No. XL-1266 SR 99 Elevation 281.0 ft (85.6 m)

Sheet 3 of 3

Project SR-99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14			50/3"		D-10		Very dense, moist, tan, silty SAND and gravel, (Glacial Till)		
	15									
50				50/0"		D-11		No Recovery		
	16							End of test hole boring at 51.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
55	17									
	18									
60										
	19									
65										
	20									
	21									
70										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/6/06,1:30:57 P4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-5-01

Job No. XL-1266 SR 99 Elevation 292.0 ft (89.0 m)

Sheet 1 of 3

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start July 10, 2001 Completion July 16, 2001 Well ID# _____

Equipment CME 45 Skid

Station 48+05 Offset 52ft Lt. Casing _____

Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 6-9in SOD/TOPSOIL		
				8		D-1		Loose, moist to damp, dark brown, gravelly, silty SAND		
5	1		>>	79		D-2	GS MC	ML, MC=9% Hard, moist, tan gray, gravelly, clayey SILT and sand		
10	2									
	3			50/3"		D-3		Very dense, moist to damp, light brown, silty SAND with some gravel, (Glacial Till)		
15	4									
	5			50/5"		D-4	GS MC	GW, MC=10% Very dense, wet, tan gray, GRAVEL and sand with some silt, (Glacial Till)		
20	6									

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:08:36 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-5-01

Job No. XL-1266 SR 99 Elevation 292.0 ft (89.0 m)

Sheet 2 of 3

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/4"		D-5		No Recovery		
	7									
25										
	8			50/2"		D-6		No Recovery: Pounding rock		
								Becomes rusty brown		
	9									
30									7/16/01	
				50/5"		D-7		No Recovery		
	10									
35				50/5"		D-8		Very dense, wet, tan gray, GRAVEL and sand with some silt, (Glacial Till)		
	11									
	12									
40				50/5"		D-9		Very dense, moist, tan gray, gravelly SAND with some silt, (Glacial Till)		
	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:06:36 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-5-01

Job No. XL-1266 SR 99 Elevation 292.0 ft (89.0 m)

Sheet 3 of 3

Project SR99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14			50/1"		D-10		No Recovery		
								End of test hole boring at 46.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
50	15									
	16									
55	17									
	18									
60	19									
65	20									
	21									
70										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05 2:06:36 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-6-01

Job No. XL-1266 SR 99 Elevation 325.0 ft (99.1 m)

Sheet 1 of 2

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start August 13, 2001 Completion August 14, 2001 Well ID# _____

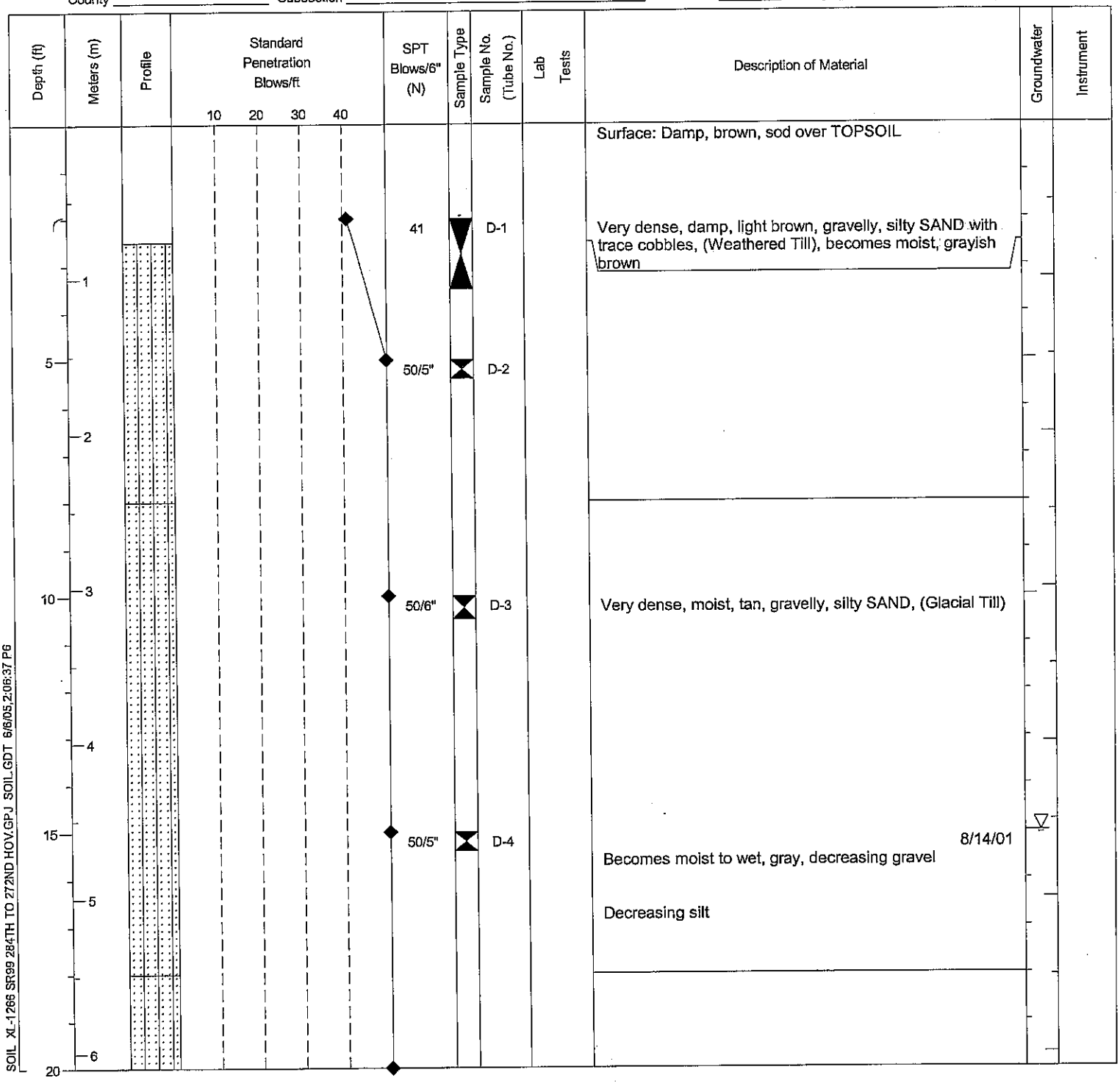
Equipment CME 45 Skid

Station 44+80 Offset 70ft Rt. Casing _____

Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____



SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 8/6/05 2:06:37 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-6-01

Job No. XL-1266 SR 99 Elevation 325.0 ft (99.1 m)

Sheet 2 of 2

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/3"		D-5	GS MC	SM, MC=9% Very dense, moist to wet, tan gray, silty SAND and gravel, (Glacial Till) Increasing gravel and sand grain size		
	7									
25				50/5"		D-6		Very dense, moist to wet, tan gray, silty, medium to coarse SAND and gravel, (Advance Outwash)		
	8									
								End of test hole boring at 26.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
30	9									
	10									
35										
	11									
	12									
40										
	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05 2:06:37 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-7-01

Job No. XL-1266 SR 99 Elevation 302.0 ft (92.0 m)

Sheet 1 of 2

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Site Address _____

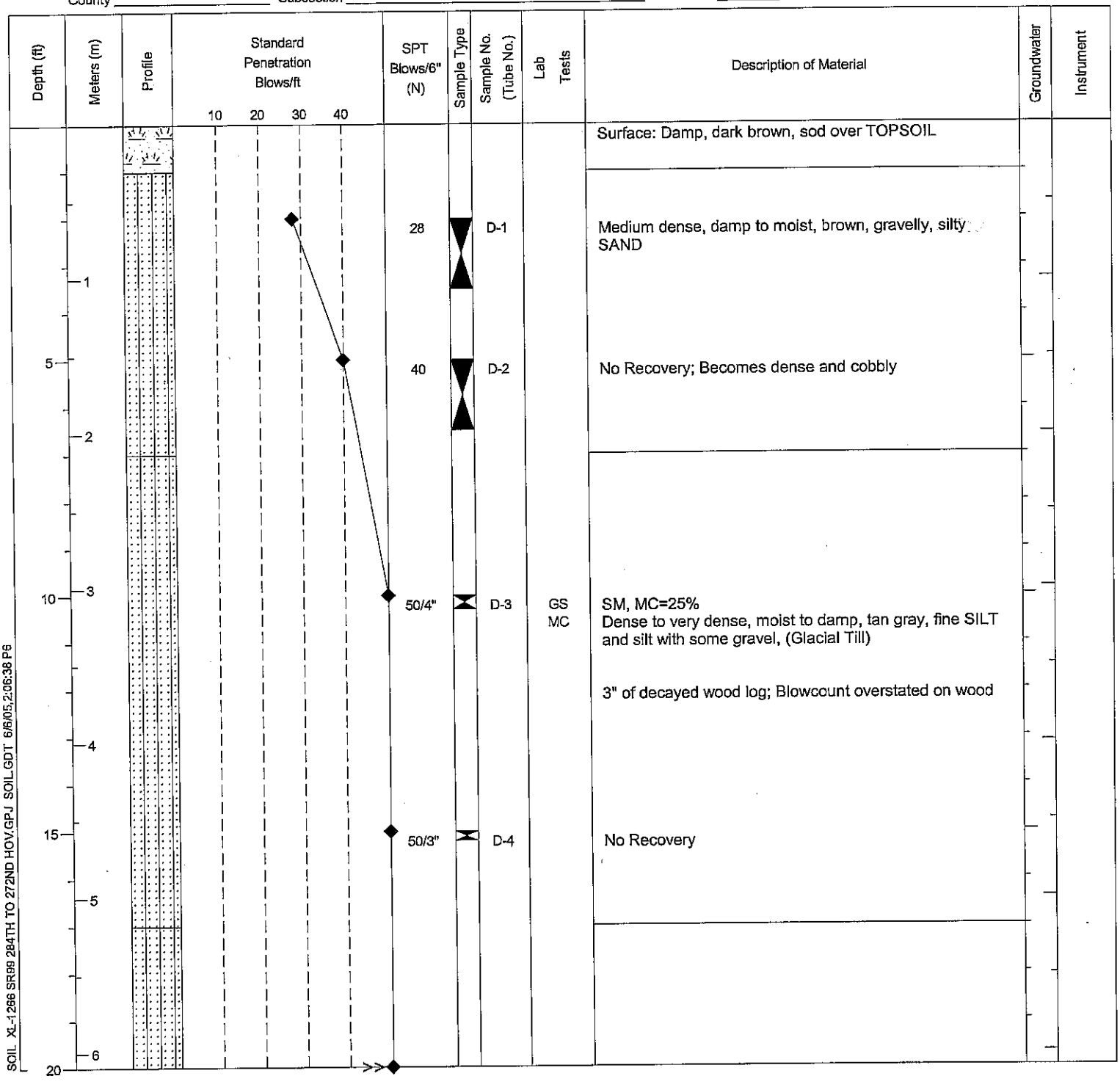
Inspector _____

Start July 17, 2001 Completion July 17, 2001 Well ID# _____ Equipment CME 45 Skid

Station 44+10 Offset 50ft Lt. Casing _____ Method Mud Rotary

Northing _____ Easting _____ Latitude _____ Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____



SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05 2:06:38 PM

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-7-01

Job No. XL-1266 SR 99 Elevation 302.0 ft (92.0 m)

Sheet 2 of 2

Project SR99 HOV S. 272nd to S. 284th St. Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				89		D-5	GS MC	SM, MC=12% Very dense, moist, tan gray, silty, gravelly SAND, (Glacial Till)		
								Decreasing gravel		
	7									
25				50/0"		D-6		Very dense, damp to moist, brownish gray, SAND and gravel with some silt and cobbles, (Advance Outwash)		
	8									
	9									
30				50/3"		D-7				
	10									
35				50/0"		D-8		No Recovery		
	11									
	12									
40				50/5"		D-9		No Recovery		
	13							End of test hole boring at 41.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:06:38 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-8-01

Job No. XL-1266 SR 99 Elevation 314.0 ft (95.7 m)

Sheet 1 of 3

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start July 18, 2001 Completion July 24, 2001 Well ID# _____

Equipment CME 45 Skid

Station 41+80 Offset 50ft Lt. Casing _____

Method Mud Rotary

Northing _____ Easting _____ Latitude _____

Longitude _____

County _____ Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Surface: 6-12" damp, dark brown, sod over TOPSOIL		
				13		D-1	GS MC	SW, MC=10% Medium dense, moist, dark brown, SAND and gravel with some silt		
	1							Becomes dense, decreasing gravel		
5				45		D-2		Becomes dense, decreasing gravel		
	2									
	3									
10			>>	65		D-3		Very dense, moist, tan gray, silty SAND and gravel		
								Hard, damp to moist, tan gray, sandy SILT		
	4									
15				50/5"		D-4		Very dense, wet to moist, tan gray, gravelly SAND		
	5							Becomes saturated	▽ 7/23/01	
	6									
20										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:06:39 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-8-01

Job No. XL-1266 SR 99 Elevation 314.0 ft (95.7 m)

Sheet 2 of 3

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/3"		D-5		Very dense, wet to moist, tan gray, gravelly SAND and silt, (Glacial Till)		
	7									
25				50/3"		D-6		No Recovery		
	8									
	9									
30				50/0"		D-7		No Recovery		
				50/0"		D-8		No Recovery: Drilled into big boulders from 35-34.5ft		
	10							Very dense, damp to moist, rusty brown, silty, find SAND with trace to some gravel		
35										
	11			>> 62		D-9		Very dense, damp to moist, rusty brown, silty, find SAND with trace to some gravel Become some cobbles		
	12									
40				50/1"		D-10		No Recovery		
	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05 2:06:39 PM

Washington State Department of Transportation

LOG OF TEST BORING

Start Card _____

HOLE No. B-8-01

Job No. XL-1266 SR 99 Elevation 314.0 ft (95.7 m)

Sheet 3 of 3

Project SR99 HOV S. 272nd to S. 284th St.

Driller _____ Lic# _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14							End of test hole boring at 41.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	15									
50										
	16									
55										
	17									
	18									
60										
	19									
	20									
65										
	21									
70										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 6/6/05,2:06:39 P6

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-1-05

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation 293.0 ft (89.3 m)

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Site Address Federal Way

Inspector Dan Reed

Start April 11, 2005 Completion April 11, 2005 Well ID# AKN-872

Equipment CME 45 w/ autohammer

Station 51+50 Offset 55 FT RT Casing HW 4.5/HQ 3.5

Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			30 50/6" (50/6")		D-1	GS	SM Silty SAND with gravel, angular, very dense, gray, moist, Homogeneous, HCl reaction not tested with large gravel and cobbles as indicated by drilling process. Length Recovered 1.0 ft, Length Retained 1.0 ft		
	1		40 50/6" (50/6")		D-2	GS	SM Silty SAND with gravel, angular, very dense, gray, moist, Homogeneous, HCl reaction not tested with large gravel as indicated by drilling process. Length Recovered 0.7 ft, Length Retained 0.7 ft		
5		>>	59/6" (59/6")		D-3	GS	SM Silty SAND with gravel, angular, very dense, gray, moist, Homogeneous, with large gravel as indicated by drilling process. HCl reaction not tested, Length Recovered 0.3 ft, Length Retained 0.3 ft		
	2								
		>>	14 34 61 (95)		D-4	GS	SM Silty SAND with gravel, angular, very dense, gray, wet, Homogeneous with large gravel as indicated by drilling process. HCl reaction not tested. Length Recovered 1.5 ft, Length Retained 1.5 ft	01/10/2006 04/11/2005	
10	3	>>	34 47 61 (108)		D-5	GS	SM Silty SAND with gravel, angular, very dense, gray, wet, Homogeneous with large gravel as indicated by drilling process ,HCl reaction not tested. Length Recovered 1.4 ft, Length Retained 1.4 ft		
	4								
15			44 50/3" (50/3")		D-6	GS	GW-GM Well graded GRAVEL with silt and sand, angular, very dense, gray, wet, Homogeneous with large gravel as indicated by drilling process, HCl reaction not tested, Length Recovered 0.7 ft, Length Retained 0.7 ft	07/05/2005	
	5								
	6								
20									

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/19/06,7:51:31 A4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-1-05

Job No. XL-1266 SR 99 Elevation 293.0 ft (89.3 m)

Sheet 2 of 2

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				36 49/6" (49/6")		D-7	GS	SW-SM Well graded SAND with silt and gravel, angular, dense, gray, moist, Homogeneous with large gravel as indicated by drilling process. HCl reaction not tested Length Recovered 1.0 ft, Length Retained 1.0 ft		

End of test hole boring at 21 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

Bail and Recharge test data. Bore hole water level before bailing 7.5', Bailed bore hole water level to 15.1', after 10 minutes 12.5', after 20 minutes 11.3', after 30 minutes 9.5', after 40 minutes 9.5', water table stabilized at 9.5'.

WATER LEVEL READINGS

DATE	DEPTH
04/11/2005	-9.60 ft.
04/11/2005	-9.50 ft.
06/23/2005	-15.20 ft.
07/05/2005	-19.10 ft.
07/27/2005	-16.00 ft.
08/11/2005	DRY
08/30/2005	DRY
09/13/2005	DRY
09/30/2005	-13.00 ft.
10/19/2005	-15.40 ft.
11/03/2005	-11.00 ft.
11/28/2005	-13.30 ft.
12/16/2005	-17.00 ft.
12/26/2005	-10.00 ft.
01/10/2006	-9.10 ft.
01/24/2006	-15.10 ft.

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/19/06,7:51:32 A4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-2-05

Job No. XL-1266 SR 99 Elevation ft (m)

Sheet 1 of 2

Project SR-99 HOV S. 272nd to S. 284th St. Driller Jody Dickson Lic# 2637

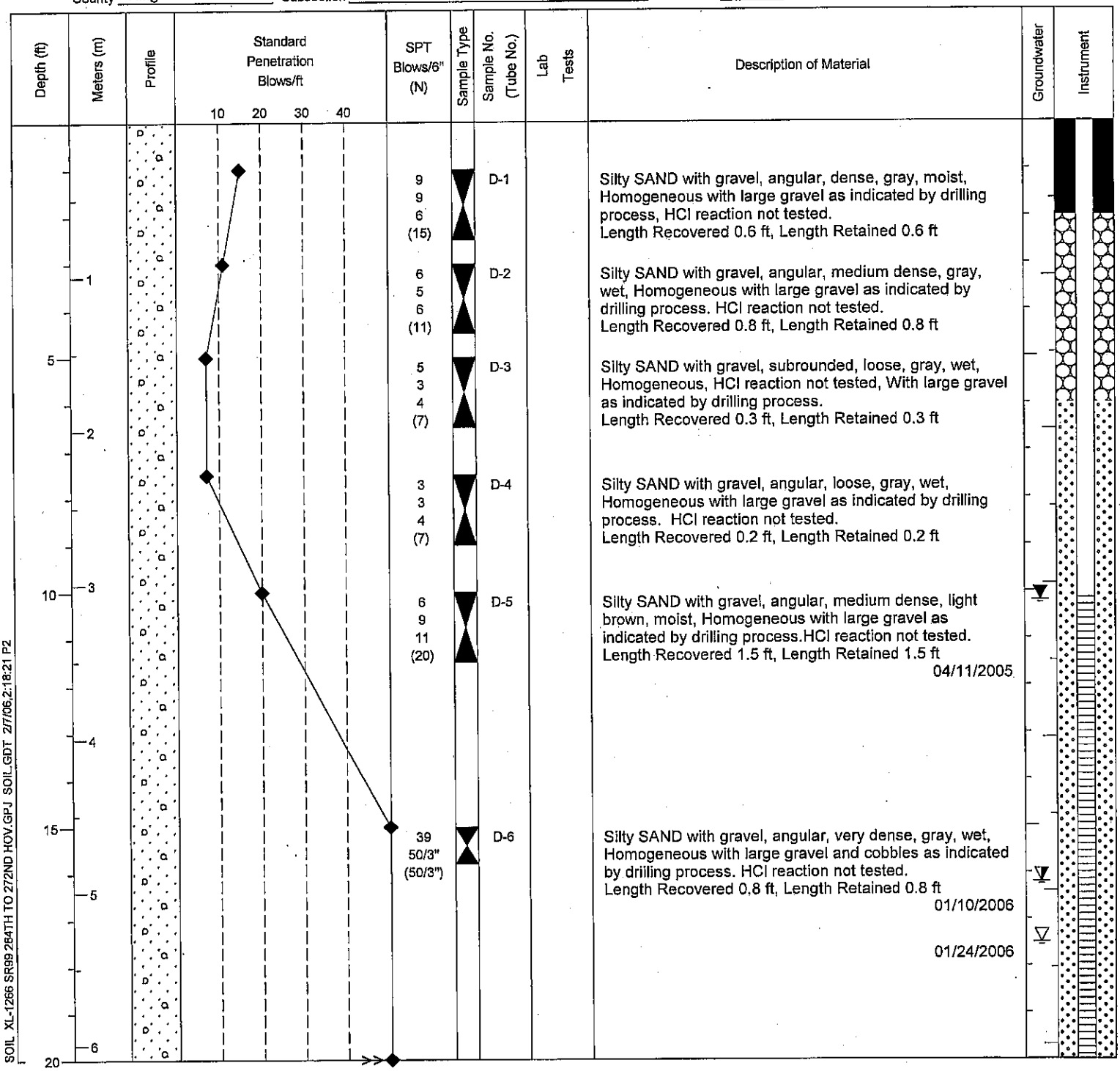
Site Address Federal Way Inspector Dan Reed

Start April 11, 2005 Completion April 11, 2005 Well ID# AKN-873 Equipment CME 45 w/ autohammer

Station 59+25 Offset 52 FT LT Casing HW 4.5/HQ-3.5 Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22



SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:21 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-2-05

Job No. XL-1266 SR 99 Elevation ft (m)

Sheet 2 of 2

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				63/6 (63/6")		D-7		Well graded GRAVEL with sand, angular, very dense, gray, wet, Homogeneous with large gravel and cobbles as indicated by drilling process. HCl reaction not tested. Length Recovered 0.4 ft, Length Retained 0.4 ft		
25	7							End of test hole boring at 20.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	8							Bail and Recharge test data. Bore hole water level before bailing 8.5', bailed bore hole water level to 18.6', after 10 minutes 15.5', after 20 minutes 13.3', after 30 minutes 11.1', after 40 minutes 10.2', after 50 minutes 10.2', water table stabilized at 10.2'.		
30	9							WATER LEVEL READINGS DATE — DEPTH 04/11/2005 — -10.30 ft. 04/11/2005 — -10.20 ft. 06/23/2005 — -17.40 ft. 07/05/2005 — DRY 07/27/2005 — DRY 08/11/2005 — DRY 08/30/2005 — DRY 09/13/2005 — DRY 09/30/2005 — DRY 10/19/2005 — DRY 11/03/2005 — DRY 11/28/2005 — DRY 12/16/2005 — DRY 12/26/2005 — DRY 01/10/2006 — -16.20 ft. 01/24/2006 — -17.50 ft.		
	10									
35	11									
	12									
40	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06,2:18:22 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-3-05

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller Jody Dickson Lic# 2637

Site Address Federal Way Inspector Dan Reed

Start April 11, 2005 Completion April 11, 2005 Well ID# AKN-874 Equipment CME 45 w/ autohammer

Station 62+80 Offset 45 FT RT Casing HW 4.5/HQ 3.5 Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				4 5 9 (14)		D-1	GS	SM Silty SAND with gravel, angular, medium dense, gray, moist, Homogeneous with large gravel as indicated by drilling process. HCl reaction not tested, Length Recovered 1.0 ft, Length Retained 1.0 ft		
	1			3 5 3 (8)		D-2	GS	GP-GM Poorly graded GRAVEL with silt and sand, subrounded, loose, gray, wet, Homogeneous, HCl reaction not tested. Length Recovered 0.8 ft, Length Retained 0.8 ft		
5				3 3 4 (7)		D-3	GS	SM Silty SAND, loose, light gray, moist, Homogeneous, HCl reaction not tested, Trace of organics. Length Recovered 1.5 ft, Length Retained 1.5 ft		
	2			3 5 6 (11)		D-4	GS	SM Silty SAND with gravel, angular, medium dense, light brown, wet, Disrupted, HCl reaction not tested, Silt lenses. Length Recovered 1.5 ft, Length Retained 1.5 ft		
10	3		>>	10 30 38 (68)		D-5	GS	SM Silty SAND with gravel, angular, very dense, gray, moist, Homogeneous, HCl reaction not tested, Length Recovered 1.5 ft, Length Retained 1.5 ft 01/24/2006	▽	
	4							04/11/2005	▽	
15				50/6" (50/6")		D-6	GS	SM Silty SAND with gravel, angular, very dense, gray, moist, Homogeneous with large gravel as indicated by drilling process. HCl reaction not tested. Length Recovered 0.5 ft, Length Retained 0.5 ft		
	5							06/23/2005	▽	
20	6		>>							

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/19/06,7:51:35 A4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-3-05

Job No. XL-1266 SR 99 Elevation ft (m)

Sheet 2 of 2

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				18 34 50 (84)		D-7	GS	GW-GM Well graded GRAVEL with silt and sand, angular, very dense, gray, wet, Homogeneous with large gravel as indicated by drilling process. HCl reaction not tested. Length Recovered 1.5 ft, Length Retained 1.5 ft		
25	7							End of test hole boring at 21.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	8							Bail and Recharge. Water level before bailing 5.3', water level after bailing 11.1', after 15 minutes 12.0', after 30 minutes 13.8', after 45 minutes 14.1', after 60 minutes 14.5', water table stabilized at 14.5'.		
30	9							WATER LEVEL READINGS DATE — DEPTH 04/11/2005 — -14.50 ft. 04/11/2005 — -14.60 ft. 06/23/2005 — -19.00 ft. 07/05/2005 — DRY 07/27/2005 — DRY 08/11/2005 — DRY 08/30/2005 — DRY 09/13/2005 — DRY 09/30/2005 — DRY 10/19/2005 — DRY 11/03/2005 — DRY 11/28/2005 — DRY 12/16/2005 — DRY 12/26/2005 — DRY 01/10/2006 — -12.60 ft. 01/24/2006 — -10.80 ft.		
	10									
35	11									
	12									
40	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 4/19/06,7:51:35 A4

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-4-05

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller Jody Dickson Lic# 2637

Site Address Federal Way Inspector Dan Reed

Start June 10, 2005 Completion June 10, 2005 Well ID# AKN-875 Equipment CME 45 w/ autohammer

Station 78+00 Offset 45' Lt Casing HQ x 22 Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			4 4 3 (7)		D - 1		Silty SAND with gravel, loose, gray, moist, Homogeneous, HCl reaction not tested. Length Recovered 0.8 ft		
	1		3 1 2 (3)		D - 2		Silty SAND with gravel, loose, light brown, wet, Homogeneous, HCl reaction not tested. Length Recovered 0.3 ft		
5			4 8 10 (18)		D - 3		Well graded GRAVEL with sand, slightly silty, subangular, medium dense, light brown, moist, Homogeneous, HCl reaction not tested. Length Recovered 0.4 ft		
	2		6 8 10 (18)		D - 4		06/10/2005 Silty SAND with gravel, medium dense, gray, moist, Homogeneous, HCl reaction not tested. Length Recovered 1.2 ft		
10	3		5 5 7 (12)		D - 5		01/10/2006 Silty SAND with gravel, medium dense, gray, wet, Homogeneous, HCl reaction not tested. Length Recovered 1.3 ft		
	4								
15			6 9 14 (23)		D - 6		Silty SAND with gravel, medium dense, gray, moist, Homogeneous, HCl reaction not tested. Length Recovered 1.5 ft		
	5								
20	6								

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:27 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-4-05

Sheet 2 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				40 60/6 (60/6")		D - 7		11/03/2005 Silty SAND with gravel, very dense, gray, moist, Homogeneous, HCl reaction not tested. Length Recovered 1.0 ft		
25	7							End of test hole boring at 21 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	8							WATER LEVEL READINGS DATE / DEPTH 06/10/2005 -7.40 ft. 06/23/2005 -17.60 ft. 07/05/2005 -18.20 ft. 07/27/2005 -18.70 ft. 08/11/2005 -19.30 ft. 08/30/2005 DRY 09/13/2005 DRY 09/30/2005 DRY 10/19/2005 DRY 11/03/2005 -20.00 ft. 11/28/2005 -18.10 ft. 12/16/2005 -18.40 ft. 12/26/2005 -14.20 ft. 01/10/2006 -9.90 ft. 01/24/2006 -10.40 ft.		
30	9									
	10									
35	11									
	12									
40	13									
45										

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:27 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-5-05

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Site Address Federal Way

Inspector Dan Reed

Start June 9, 2005 Completion June 9, 2005 Well ID# AKN-876

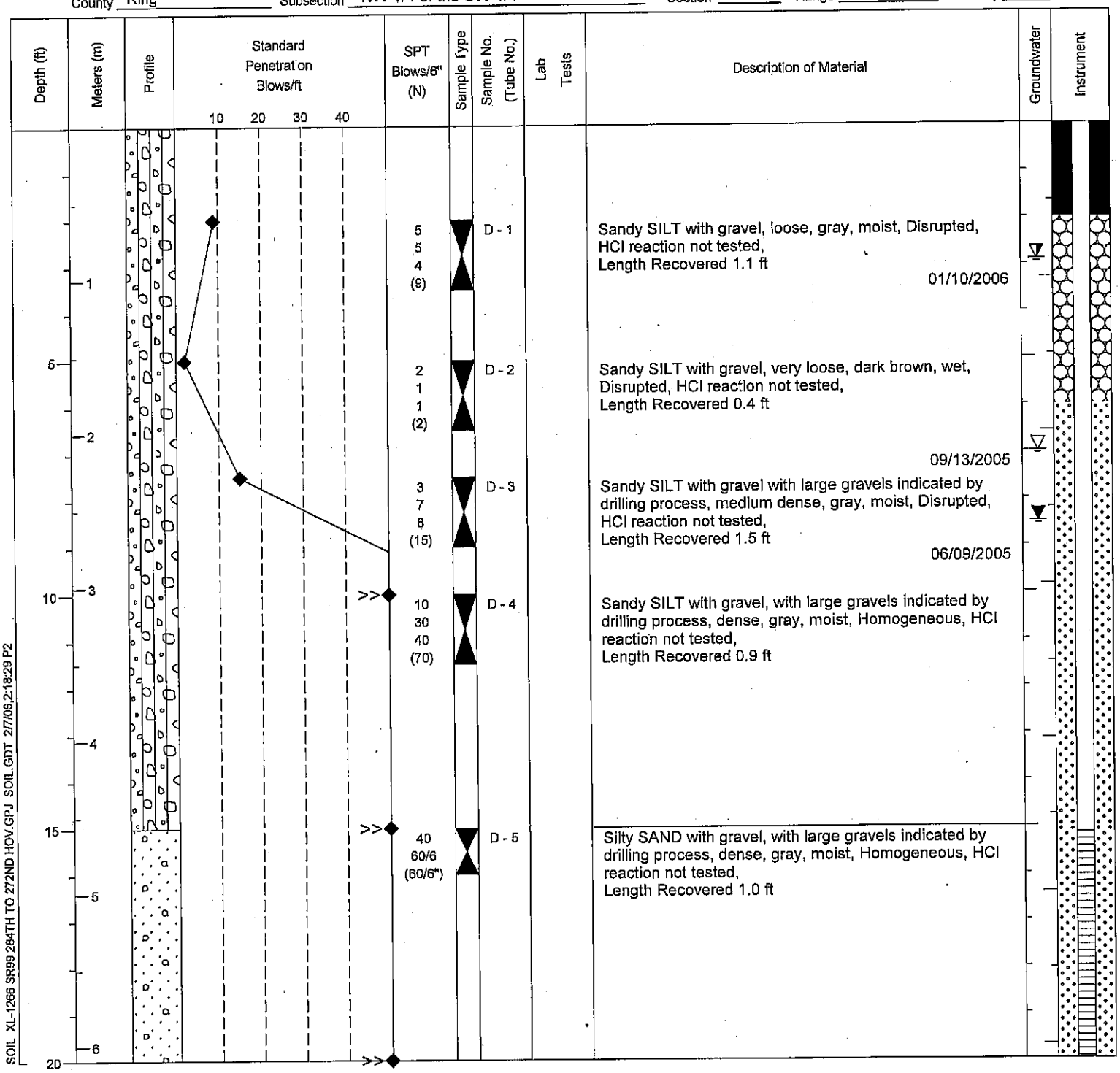
Equipment CME 45 w/ autohammer

Station 78+00 Offset 80' Rt. Casing HQ x 27

Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22



SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:29 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-5-05

Sheet 2 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			>>	59/6 (59/6")		D - 6		Silty SAND with gravel, very dense, gray, moist, Homogeneous, HCl reaction not tested, Length Recovered 0.5 ft		
25	7		>>	71/6 (71/6")		D - 7		Silty SAND with gravel with large gravels indicated by drilling process, very dense, gray, moist, Homogeneous, HCl reaction not tested, Length Recovered 0.5 ft		
	8							End of test hole boring at 25.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
30	9									
	10									
35	11									
	12									
40	13									
45										

WATER LEVEL READINGS

DATE	DEPTH
06/09/2005	-8.50 ft.
06/23/2005	-5.30 ft.
07/05/2005	-6.50 ft.
07/27/2005	-6.70 ft.
08/11/2005	-7.00 ft.
08/30/2005	-6.80 ft.
09/13/2005	-7.00 ft.
09/30/2005	-5.60 ft.
10/19/2005	-5.10 ft.
11/03/2005	-4.20 ft.
11/28/2005	-4.70 ft.
12/16/2005	-6.90 ft.
12/26/2005	-4.00 ft.
01/10/2006	-2.90 ft.
01/24/2006	-4.50 ft.

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:30 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-6-05

Job No. XL-1266 SR 99 Elevation ft (m)

Sheet 1 of 2

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Site Address Federal Way

Inspector Dan Reed

Start June 10, 2005 Completion June 10, 2005 Well ID# AKN-877

Equipment CME 45 w/ autohammer

Station 70+00 Offset 35' Lt. Casing HQ x 22

Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 33 Range 4 E Township 22

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				4 2 3 (5)		D - 1		Silty SAND with gravel, loose, gray, moist, Homogeneous, HCl reaction not tested. Length Recovered 1.0 ft		
	1			2 3 2 (5)		D - 2		Silty SAND with gravel, loose, gray, wet, Disrupted, HCl reaction not tested. Length Recovered 1.0 ft		
5				1 1 1 (2)		D - 3		SILT with sand and carcoal, loose, light brown, wet, Disrupted, HCl reaction not tested. Length Recovered 1.5 ft		
	2			3 6 14 (20)		D - 4		Silty SAND with gravel, medium dense, light brown, wet, Disrupted, HCl reaction not tested. Length Recovered 0.7 ft 06/10/2005 01/10/2006		
10	3		>>	14 22 30 (52)		D - 5		Silty SAND with gravel, very dense, gray, wet, Disrupted, HCl reaction not tested. Length Recovered 1.1 ft		
	4									
15				17 22 25 (47)		D - 6		Silty SAND with gravel, with large gravels as indicated by drilling process, dense, gray, wet, Homogeneous, HCl reaction not tested. Length Recovered 1.4 ft 06/23/2005		
	5									
20	6									

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:32 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01159

HOLE No. P-6-05

Sheet 2 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St.

Driller Jody Dickson Lic# 2637

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				25 50/6 (50/6")		D - 7		Silty SAND with gravel, very dense, gray, wet, Homogeneous, HCl reaction not tested. Length Recovered 1.0 ft		

End of test hole boring at 21 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.

WATER LEVEL READINGS

DATE	DEPTH
06/10/2005	-8.60 ft.
06/23/2005	-18.00 ft.
07/05/2005	N/A (vehicle parked on lid)
07/27/2005	DRY
08/11/2005	DRY
08/30/2005	DRY
09/13/2005	DRY
09/30/2005	DRY
10/19/2005	DRY
11/03/2005	-15.80 ft.
11/28/2005	-15.80 ft.
12/16/2005	-16.90 ft.
12/28/2005	-11.60 ft.
01/10/2006	-9.30 ft.
01/24/2006	-9.70 ft.

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06 2:18:32 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01378

HOLE No. P-7-05

Sheet 1 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller Sean Verlo Lic# 2516

Site Address Federal Way Inspector Mike Brun

Start December 12, 2005 Completion December 13, 2005 Well ID# APM-399 Equipment CME 45 with Auto Hammer

Station 49+00 Offset 28' Left Casing HQ Method Wet Rotary

Northing Easting Latitude Longitude

County King Subsection SW1/4 of the NW1/4 Section 33 Range 4 E Township 22 N

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			5 5 7 6 (12)		D-1		Sandy SILT with gravel, medium dense, brown, moist, Homogeneous, HCl reaction not tested Length Recovered 0.5 ft, Length Retained 0.5 ft		
	1								
5			5 6 4 6 (10)		D-2		Sandy SILT with gravel, loose, brown, moist, Homogeneous, HCl reaction not tested Length Recovered 0.8 ft, Length Retained 0.8 ft		
	2								
			3 4 4 9 (8)		D-3		Silty SAND with gravel, loose, brown, dry, Homogeneous, HCl reaction not tested Length Recovered 0.7 ft, Length Retained 0.7 ft		
10	3	>>	12 29 38 (67)		D-4		Silty SAND with gravel, very dense, brown, dry, Homogeneous, HCl reaction not tested Length Recovered 0.7 ft, Length Retained 0.7 ft		
	4								
15		>>	24 34 50 (84)		D-5		Sandy SILT with gravel, very dense, brown, moist, Homogeneous, HCl reaction not tested Length Recovered 1.0 ft, Length Retained 1.0 ft		
	5								
	6								
20		>>							

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06,2:18:35 P2

Washington State Department of Transportation

LOG OF TEST BORING

Start Card RE-01378

HOLE No. P-7-05

Sheet 2 of 2

Job No. XL-1266 SR 99 Elevation ft (m)

Project SR-99 HOV S. 272nd to S. 284th St. Driller Sean Verlo Lic# 2516

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				16 33 50 (83)		D-6		Silty SAND with gravel, very dense, brown, moist, Homogeneous, HCl reaction not tested Length Recovered 0.8 ft, Length Retained 0.8 ft 01/10/2006 12/13/2005	▽ ▼	
25	7			50/3 (50/3")		D-7		12/16/2005 Sandy SILT with gravel, very dense, brown, moist, Homogeneous, HCl reaction not tested Length Recovered 0.1 ft, Length Retained 0.1 ft	▽	
30	8 9							End of test hole boring at 25.2 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
35	10 11									
40	12									
45	13									

WATER LEVEL READINGS

DATE	DEPTH
12/13/2005	-21.00 ft.
12/16/2005	-24.10 ft.
12/28/2005	-22.50 ft.
01/10/2006	-20.40 ft.
01/24/2006	-23.10 ft.

SOIL XL-1266 SR99 284TH TO 272ND HOV.GPJ SOIL.GDT 2/7/06,2:18:35 P2

APPENDIX B: Laboratory Test Results

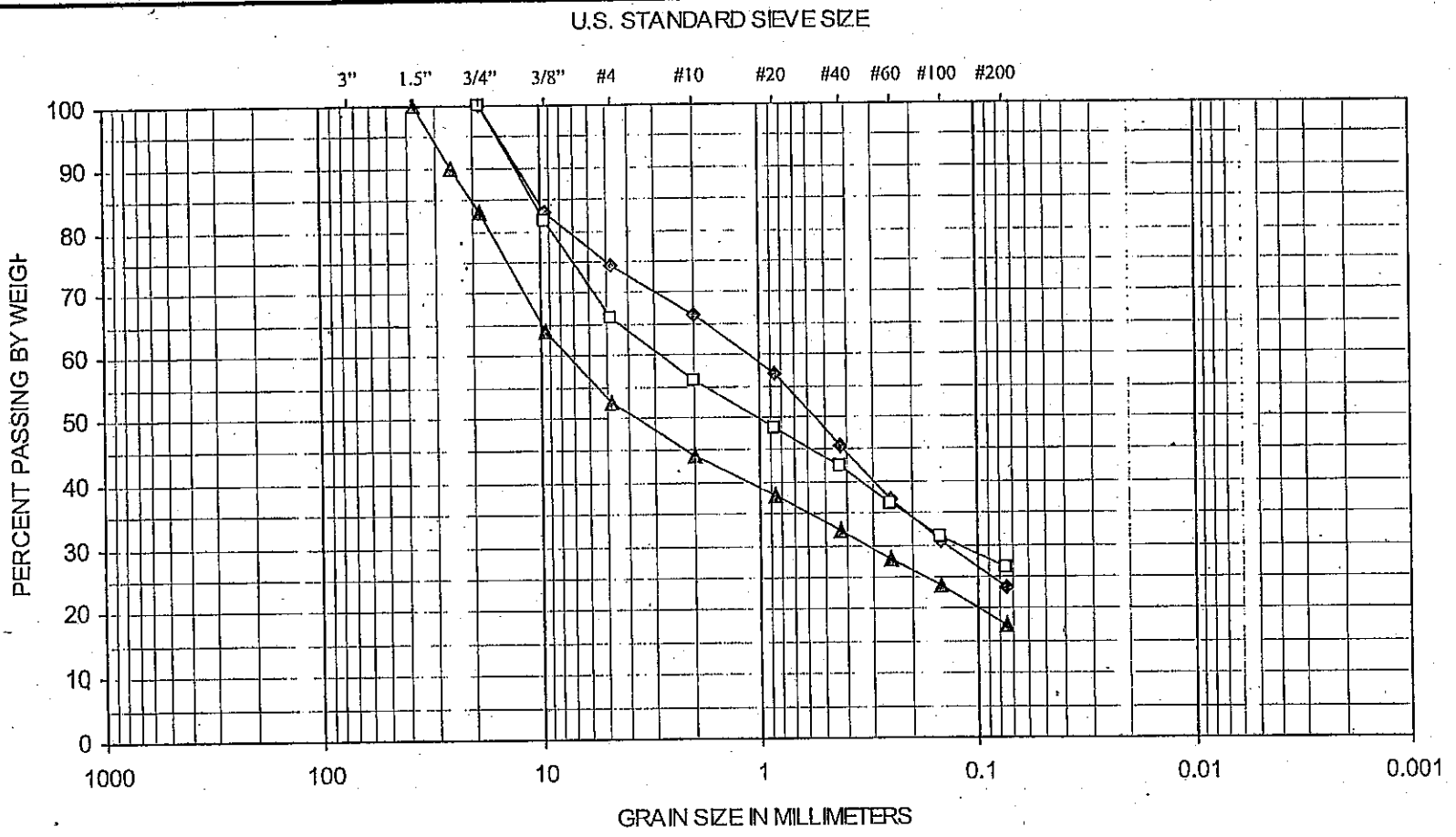
Y:\Geotech\2001\21022\Lab\sieve

CivilTech Corporation

SIEVE ANALYSIS RESULTS

SR-99 HOV -- S.272nd TO S.284th ST.
Federal Way, WA Job No. 21022

PLATE B-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	BH-1-01 S3	8.0'-9.5'	Silty, gravelly SAND (SM)
□	BH-2-01 S5	19.0'-20.5'	Silty SAND And fine Gravel (SM-GP)
▲	BH-3-01 S2	4.0'-5.5'	Silty GRAVEL And Sand (GM-SM)

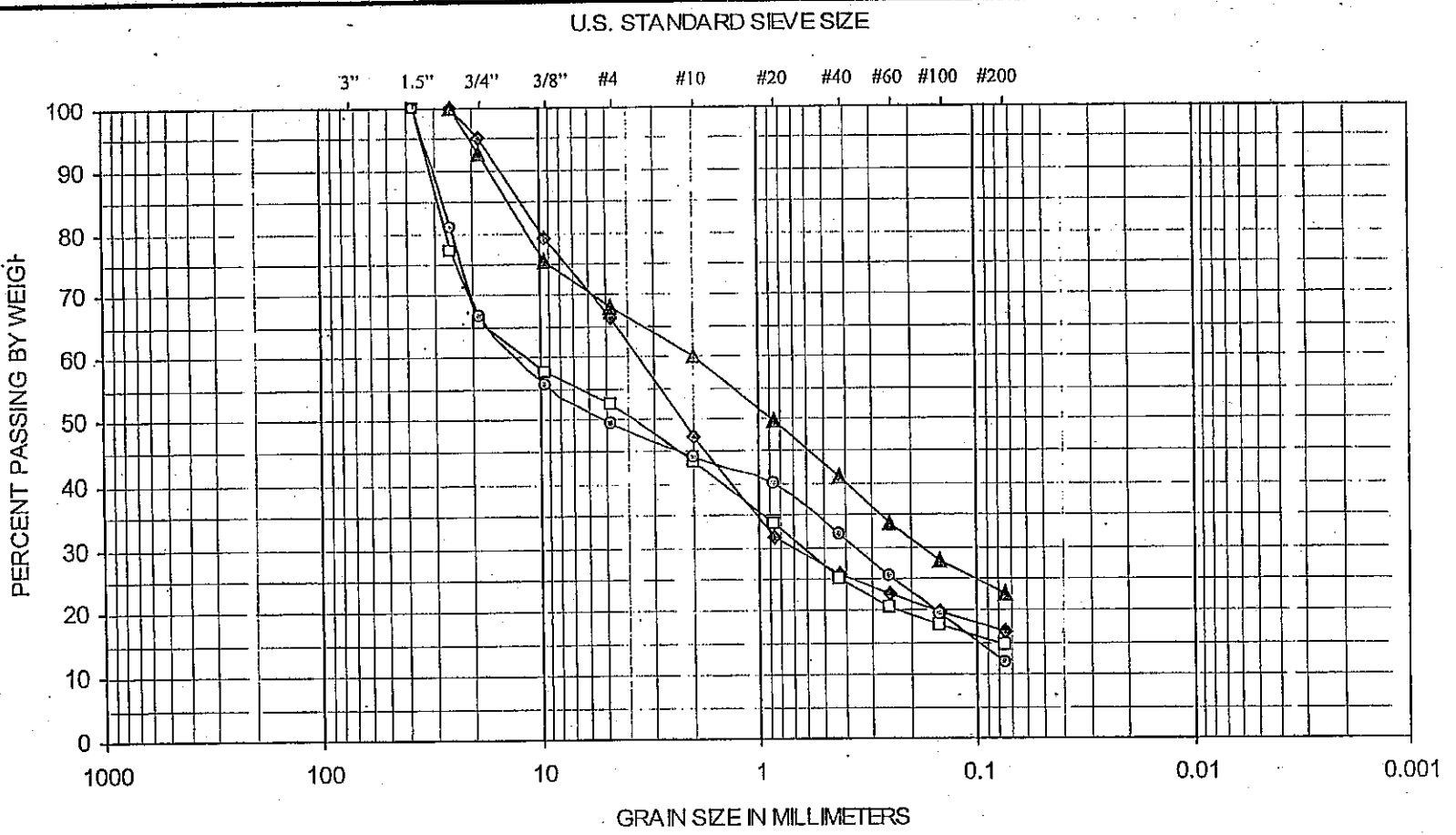
Y:\Geotech\2001\21022\Lab\sieve

CivilTech Corporation

SR-99 HOV -- S.272nd TO S.284th ST.
Federal Way, WA Job No. 21022

SIEVE ANALYSIS RESULTS

PLATE B-2



*COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	BH-4-01 S2	5.0'-6.5'	Silty, gravelly SAND (SM)
□	BH-4-01 S4	15.0'-16.5'	Silty SAND And fine Gravel (SM-GM)
▲	BH-5-01 S2	5.0'-6.5'	Silty GRAVEL And Sand (GM-SM)
⊙	BH-5-01 S4	16.0'-17.5'	GRAVEL And Sand with some silt (GW-SW)

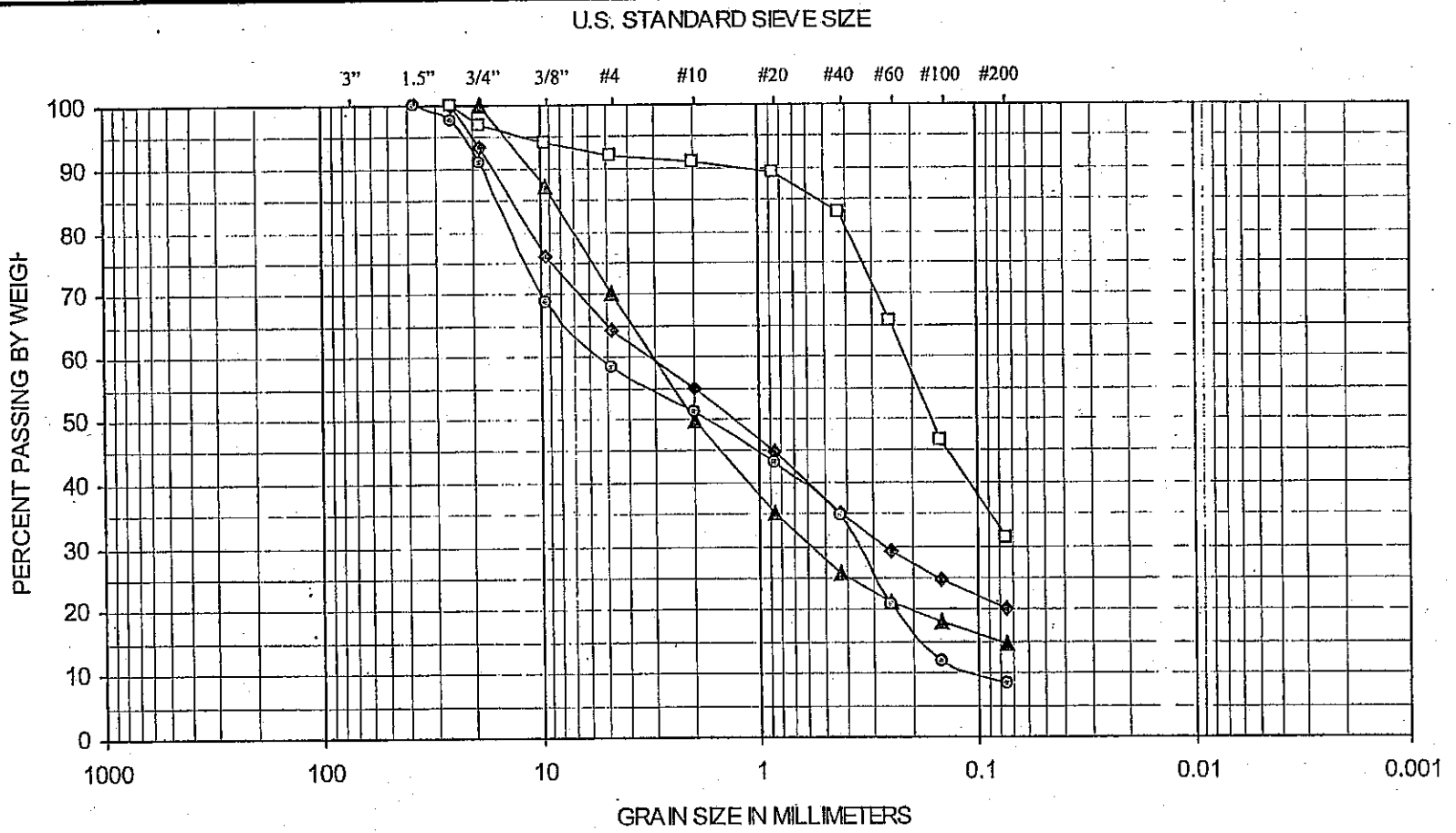
Y:\Geotech\2001\21022\Lab\sieve

CivilTech Corporation

SIEVE ANALYSIS RESULTS

SR-99 HOV -- S.272nd TO S.284th ST.
Federal Way, WA Job No. 21022

PLATE B-3



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	BH-6-01 S5	20.0'-21.5'	Silty SAND And Gravel (SM-GM)
□	BH-7-01 S3	10.0'-11.5'	SAND And Silt with some gravel (SM-ML)
▲	BH-7-01 S5	20.0'-21.5'	Silty, gravelly SAND (SM)
◎	BH-8-01 S1	2.0'-3.5'	SAND And Gravel with some silt (SW-GW)

Job No. **XL-1266** Date **April 19, 2006**

Hole No. **P-1-05** Sheet **1** of **2**

Project **SR-99 HOV S. 272nd to S. 284th St.**

Laboratory Summary

Washington State Department of Transportation

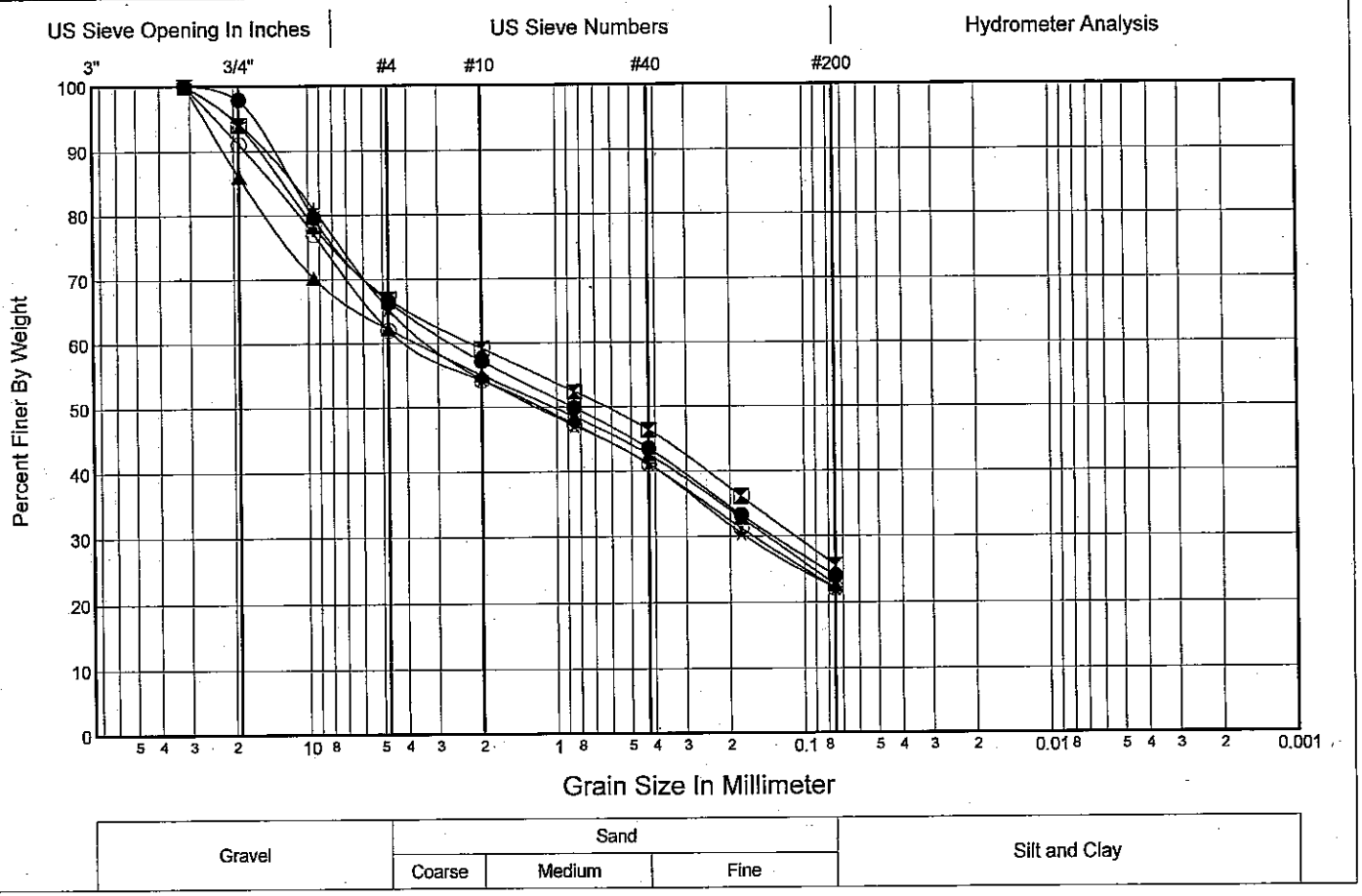
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	1.0	0.30	D-1	SM	See boring log	SILTY SAND with GRAVEL				
⊠	3.0	0.91	D-2	SM	See boring log	SILTY SAND with GRAVEL				
▲	5.0	1.52	D-3	SM	See boring log	SILTY SAND with GRAVEL				
★	7.5	2.29	D-4	SM	See boring log	SILTY SAND with GRAVEL				
⊙	10.0	3.05	D-5	SM	See boring log	SILTY SAND with GRAVEL				

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	33.5	42.6	24.0		
⊠	33.1	41.4	25.5		
▲	37.8	39.6	22.6		
★	34.7	43.2	22.1		
⊙	38.0	39.8	22.1		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	2.598	0.87	0.13		
⊠	2.195	0.65	0.11		
▲	3.651	1.04	0.14		
★	3.128	1.20	0.17		
⊙	3.811	1.19	0.16		



Job No. **XL-1266** Date **April 19, 2006**

Hole No. **P-1-05** Sheet **2** of **2**

Project **SR-99 HOV S. 272nd to S. 284th St.**

Laboratory Summary

Washington State Department of Transportation

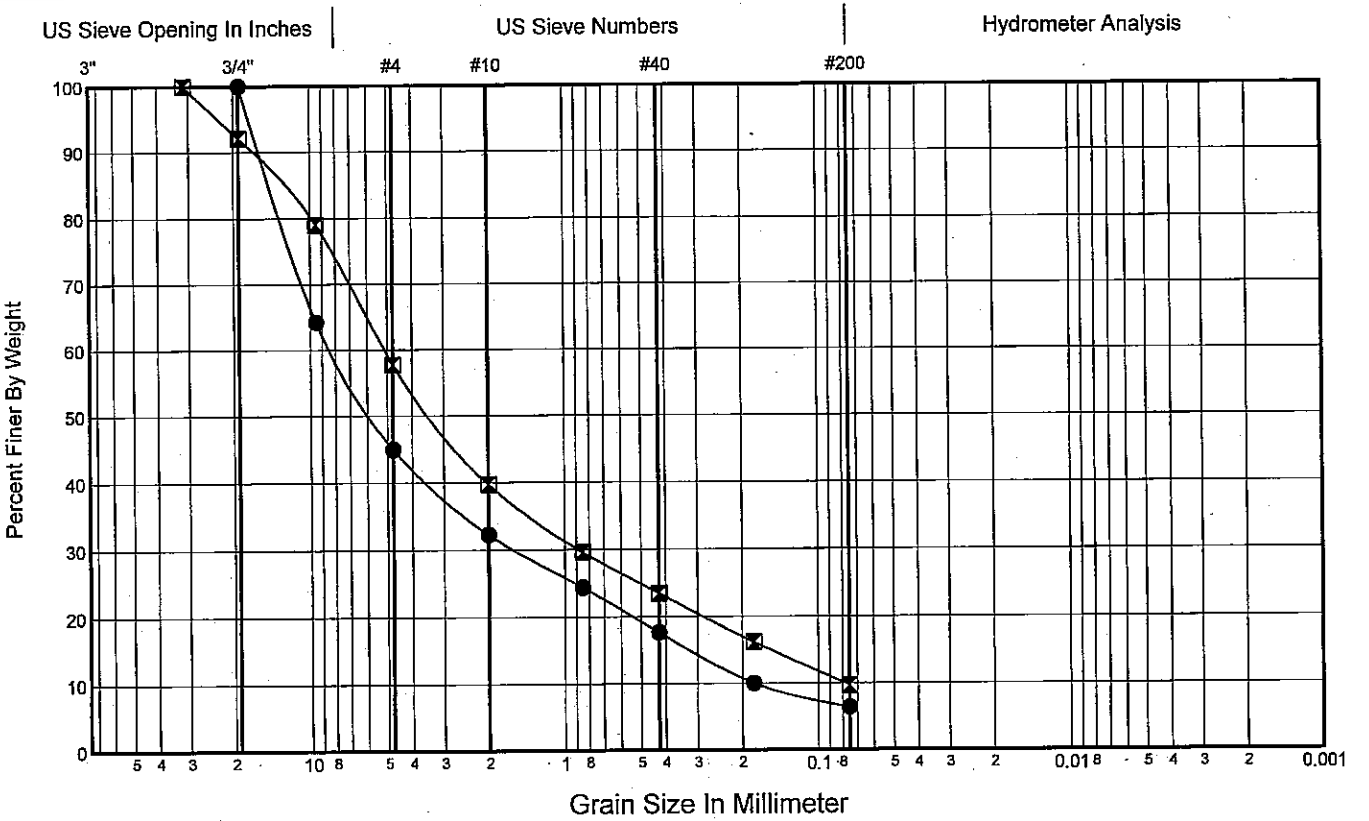
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	15.0	4.57	D-6	GW-GM	See boring log	WELL-GRADED GRAVEL with SILT and SAND				
⊠	20.0	6.10	D-7	SW-SM	See boring log	WELL-GRADED SAND with SILT and GRAVEL				

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	55.0	38.6	6.4	1.7	45.7
⊠	42.3	48.0	9.7	1.9	65.6

GRADATION VALUES

	D60	D50	D30	D20	D10
●	8.172	5.70	1.57	0.54	0.179
⊠	5.117	3.28	0.88	0.28	0.078



Job No. **XL-1266** Date **April 19, 2006**

Hole No. **P-3-05** Sheet **1** of **2**

Project **SR-99 HOV S. 272nd to S. 284th St.**

Laboratory Summary

Washington State Department of Transportation

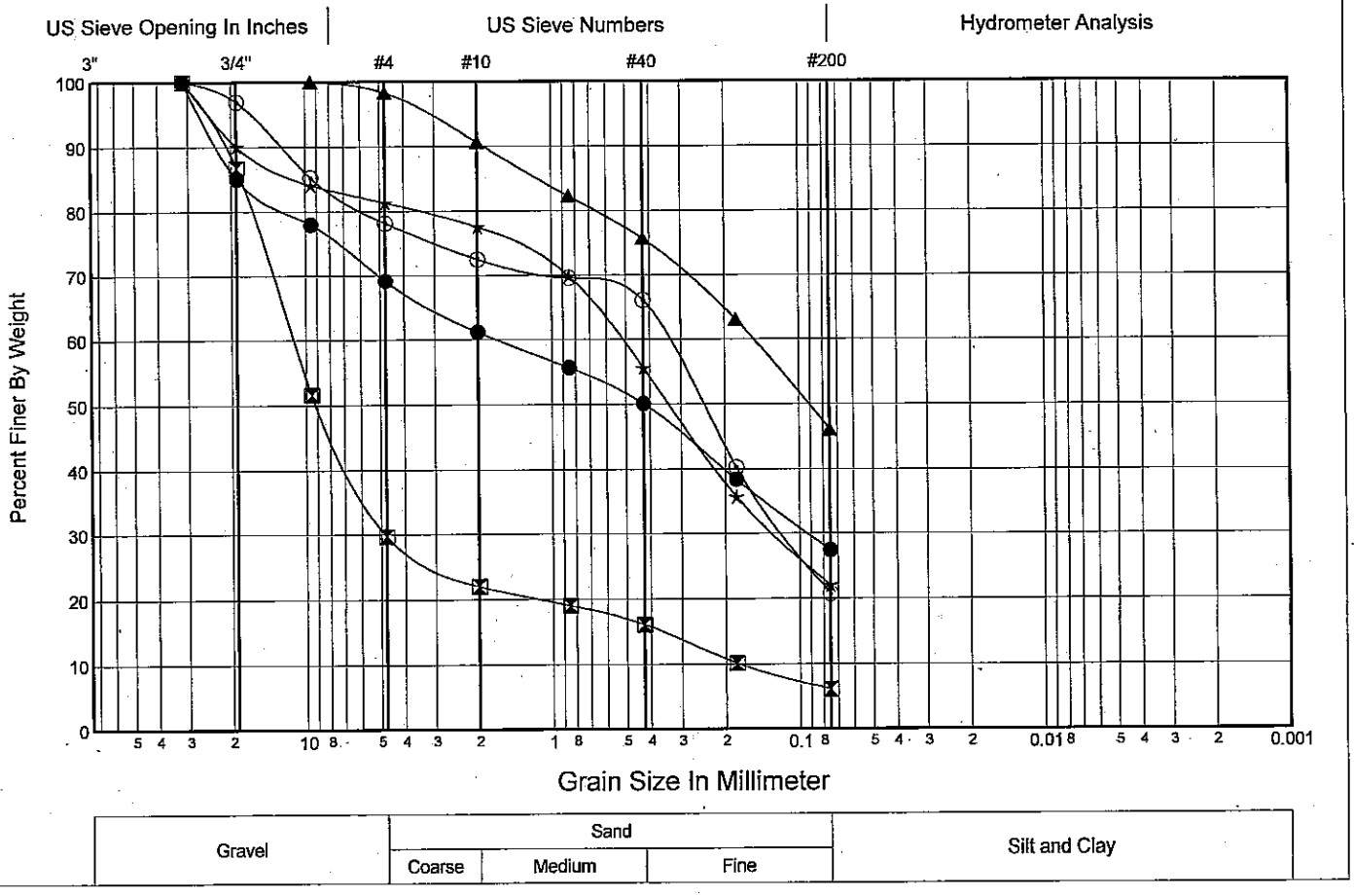
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	1.0	0.30	D-1	SM	See boring log	SILTY SAND with GRAVEL				
⊠	3.0	0.91	D-2	GP-GM	See boring log	POORLY GRADED GRAVEL with SILT and SAND				
▲	5.0	1.52	D-3	SM	See boring log	SILTY SAND				
★	7.5	2.29	D-4	SM	See boring log	SILTY SAND with GRAVEL				
⊙	10.0	3.05	D-5	SM	See boring log	SILTY SAND with GRAVEL				

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	30.9	41.8	27.4		
⊠	70.3	23.6	6.1	11.7	63.7
▲	1.7	52.2	46.1		
★	18.7	59.3	22.0		
⊙	21.9	57.4	20.7		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	1.680	0.42	0.09		
⊠	11.221	9.04	4.80	1.14	0.176
▲	0.154	0.09			
★	0.527	0.33	0.13		
⊙	0.347	0.25	0.11		



Job No. **XL-1266** Date **April 19, 2006**

Hole No. **P-3-05** Sheet **2** of **2**

Project **SR-99 HOV S. 272nd to S. 284th St.**

Laboratory Summary

Washington State Department of Transportation

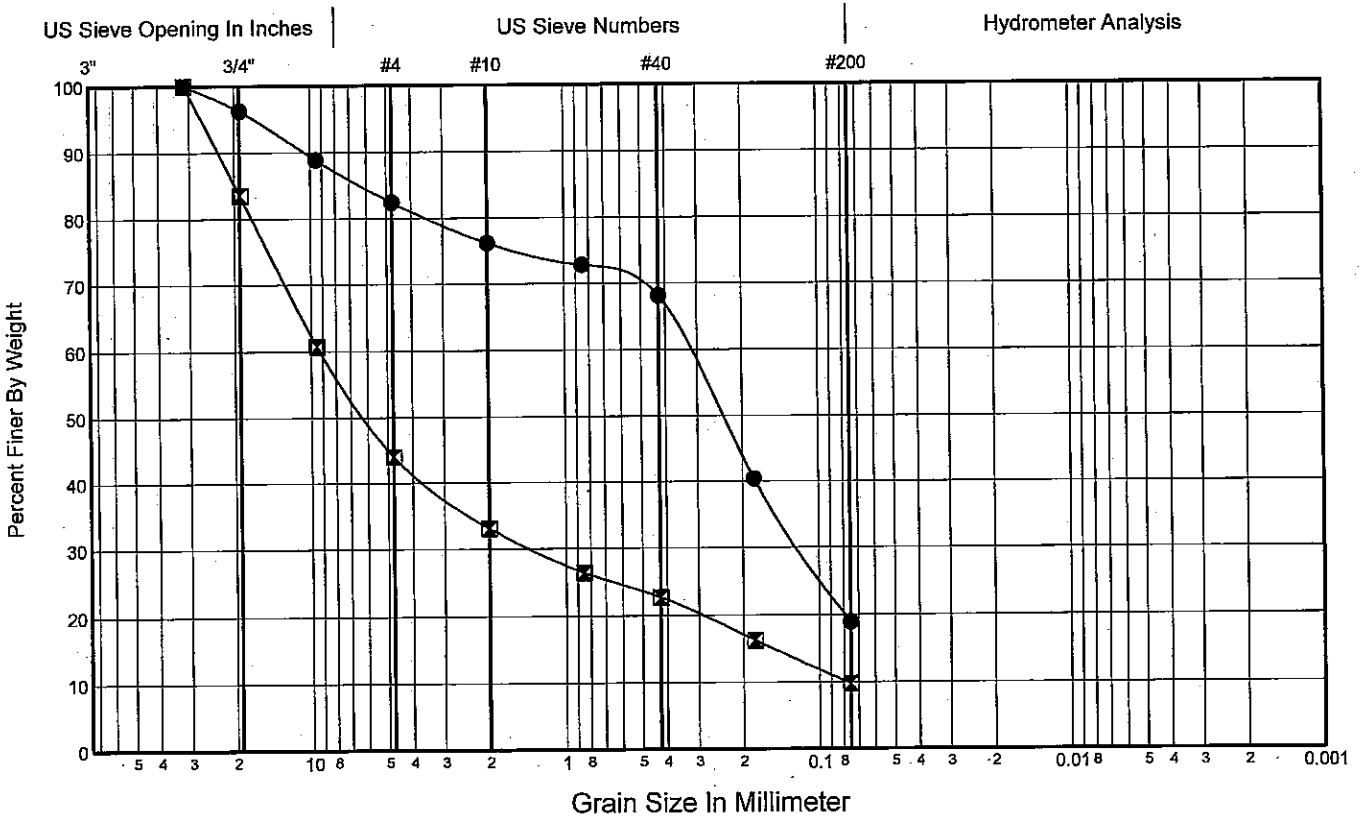
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	15.0	4.57	D-6	SM	See boring log	SILTY SAND with GRAVEL				
⊠	20.0	6.10	D-7	GW-GM	See boring log	WELL-GRADED GRAVEL with SILT and SAND				

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	17.6	63.4	18.9		
⊠	56.0	34.2	9.7	2.6	119.0

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.331	0.24	0.12	0.08	
⊠	9.227	6.09	1.35	0.30	0.078



APPENDIX C: SIL-Shaft Input Parameters

SIL-Shaft Input Data

Bridge No. or Name Luminaire and Power Pole Lateral Load Analyses
Pier No(s). Static Case
Ground Surface Elevation 308.0 (ft)

Layer	Soil Type	Layer Thickness (ft)	Btm. Elev. (ft)	Effective Unit Weight (pcf)	Friction[1] Angle (deg)	ε_{50} (%)	Liq.	Soil Cohesion (psf)	s_u at Top of Layer (psf)	s_u at Bottom of Layer (psf)	Rock Comp. Stgth (psf)	SPT Corrected Blowcounts (bpf)	Fines Content (%)	Angularity
1	Sand	23	285	130	40	0.015	No							
2	Sand	52	233	68	40	0.015	No							

[1] For Rock, this is the effective friction angle of the rock mass.

Project: XL1266 SR99 S. 272nd to S. 284th St - HOV

File: U:\SR99\284th to 272nd HOV\SIL SHAFT - Power and Luminaire Poles
Date: 4/20/2006